EVALUATING CONSTRUCTION ACTIVITIES IMPACTING ON WATER RESOURCES

Ontario

Ministry of the Environment

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EVALUATING CONSTRUCTION ACTIVITIES

IMPACTING ON WATER RESOURCES

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FOREWORD

To assist Ministry of the Environment staff with their assessment of construction activities,staff of the Water Resources Branch have prepared a reference document which outlines potential water resource impacts and suggests appropriate mitigation measures. We hope the document will find application on a wide range of evaluations from brief "quasi-approvals" to formal Environmental Assessments. A flow chart for a typical assessment is provided on page V of the handbook.

The following summarize the approach followed in the compilation of the construction activities reference document and highlight key factors to be considered in the evaluation methodology.

Upon Receipt of a proposal to be reviewed, the evaluator first determines the location,size and timing of the project.

Location

The location is important with regards to a) topography - if the proposal calls for construction on level ground or ground with 'gentle' slopes the potential problems resulting from construction (example erosion) might not be as severe as a similar project in an area with steep slopes and/or highly erodible soils. The problem is further complicated with removal of vegetation and proximity of adjacent water bodies.

b) water uses

Work in an area adjacent to water intakes, recreational areas or important fisheries habitat would be more critical than in areas without such uses.

Timing

There is always some seasonal variation in hydrological, water quality and soil characteristics. Construction could have less effect during a particular time of the year due to variations in weather, streamflow, plant and animal life cycles etc. The evaluator would have to determine suitable time to help minimize potential impacts.

Size

If the project involves a small area and a small physical disruption,concerns over impact might not be as strong as for projects of greater magnitude. It will be critical for evaluators to develop a sense of scale that will allow for protection of the environment without burdening themselves and proponents with inappropriate information requirements.

Previous Correspondence on the Area

Previous correspondence can give an indication of what other evaluators thought of the area, studies done, other projects carried out, and would give some indication whether the area can absorb the impacts of the present proposal.

Project Scope

The evaluator should determine whether it is a single operation, e.g. dredging or filling or grading etc. or whether it is a combination of different construction operations e.g. dredging, filling and dock construction to create a new harbour. In the latter case each of the different operations would have its characteristic impact. The evaluator should then look at the total impact of the entire project. At the same time the evaluator may want to look at the alternatives to each operation and decide how best to minimize possible impact.

Mitigative Measures

The evaluator should determine the adequacy of any proposed mitigative measures. There are numerous factors that can be controlled to minimize construction impacts. These include choosing a) proper timing, equipment and method of carrying out the particular proposal. b) using interim control measures, these would include measures to prevent siltation of water courses etc. Proper judgment is required to determine the need or adequacy for the particular measures proposed. In some instances, especially when the duration of the operation is very short such measures might not be required and if used may pose a greater problem with regards to installation and removal than if no controls were used. The evaluator should determine the impacts with and without control measures and where appropriate suggest measures that should be undertaken.

The evaluation does not end at the construction level. The evaluator should determine the requirements for future maintenance work, the restoration methods, and the durability of the structure (this latter point may be with regards to a landfill being eroded, or the adequacy of dykes containing contaminated spoils etc.).When specifying criteria to be maintained the evaluator should indicate why particular criteria are used. That is, which water use is being protected.

Many of the points listed above are described for different construction activities in the attached handbook, called "Evaluating Construction Activities Impacting on Water Resources". It is difficult to set down every detail of the assessment process on paper but it is hoped that most of the major concerns are covered.

We welcome any comments on the handbook. It is our intent to revise the material as more experience is accumulated in this rather poorly understood field. We are also available to provide assistance on any specific project evaluation.

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Water Resources Planning Unit

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PREFACE

This document is drawn up with the view of providing each region with similar basic information to be used in the impact assessment procedures.

The aim in this booklet is to list different construction activities and:

1. Define the activity for purposes of this discussion.

2. List some of the possible effects the activity may have on water resources.

3. List some of the factors to be considered in evaluating the particular activity.

4. Offer recommendations in the form of guidelines to mitigate possible adverse effects.

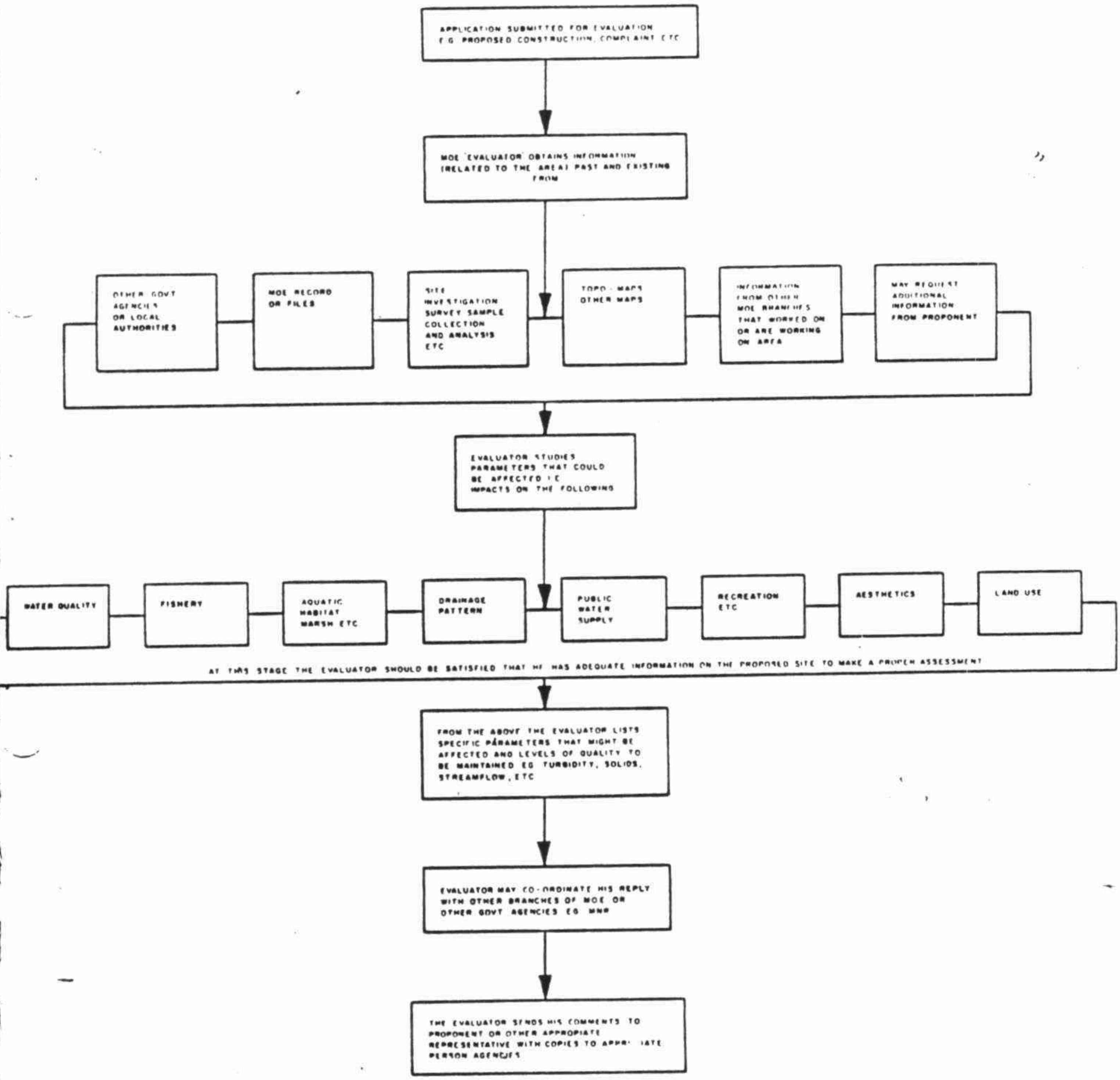
In addition to our revised marine construction guidelines, the text describes current thinking on other construction and land use activities. As new procedures develop from evolving technology, they will be reviewed and added to update this document. In view of this, the contents have been arranged to accommodate future material without disrupting the page numbering system.

The following diagram outlines the stepwise procedure in assessing the impact of a project on water resources.

It is important to maintain careful control over construction activities and to view each project in its total context. In this respect, MOE would have to study each proposal thoroughly and make recommendations based on the particular site and proposal.

In some instances a deliberate effort has been made to include some of the post-operational effects in the assessment procedure. This is quite evident for small scale projects where it is intended that potential problems arising from the "construct" would be worked out prior to initiation of the project.

PROJECT IMPACT ASSESSMENT



IMPACT ON THE ENVIRONMENT

Consideration will be given to all factors related to a project during the assessment of impact. The applicant is requested to consider the short and long term effects on water quality, sediment quality and thus on other water uses.

Proposed projects will not be approved where their construction will result in water quality impairment in violation of the "criteria" at the limit of an established mixing zone. These criteria are contained in the MOE publication "Guidelines and Criteria for Water Quality Management in Ontario, June 1970".

All water supplies must be protected throughout the construction program. Where water supplies are impaired by construction, an alternate source of supply must be provided to the affected parties in sufficient amounts and acceptable quality to meet their normal requirements for as long as impairment exists. The owner of the new work is liable for additional treatment costs or costs of providing and maintaining alternate supplies.

Particular attention should be given to the effects on sediment quality since construction operations frequently generate large quantities of silt which may adversely affect the benthic community (bottom organisms) long after the water quality has reverted to normal.

Note: Where the proponent's submission indicates he does not have the necessary expertise to assess the environmental impact and the scale of the project is such that MOE staff cannot complete the assessment, the proponent may be requested to engage a competent consultant to do so.

ALTERNATIVES TO THE PROPOSAL

The applicant should recognize the alternatives to his proposal (or segments thereof) and enumerate them. It is recommended that the applicant indicate his weighting of the alternatives. The Ministry in its evaluation will consider the relationship between local short term uses of man's environment and the maintenance and enhancement of long term productivity. Further considerations will include determination of irreversible and irretrievable committments of resources and objections raised by other agencies and individuals.

1. ASPECTS OF SEDIMENTATION

Soil particles are first removed from an area through a combination of processes termed erosion. The major forces effecting erosion are wind, water and ice.

When rain falls over an area, some of it is absorbed by the soil, after the soil is saturated the remaining water forms overland flow. The ability of soil to absorb water is determined by its infiltration rate which in turn depends on a number of factors including - soil texture, soil structure, vegetation cover, moisture content, etc.

Vegetative cover greatly influences soil erosion. The density and composition of vegetation is dependent on temperature and rainfall.

Topography of the land is the most important factor influencing the rate of erosion

The velocity of water moving overland increases with the degree of slope and higher velocities tend to move larger particles. Rainfall - starts the process and determines the amount and duration of erosion. The flow of water over land without depressions for water to accumulate is termed 'overland or sheet flow'. In the presence of small depressions, rill or gully flow may occur. Rills - are small depressions (usually evident on newly cut roadbanks, embankments, etc.) formed from sheet erosion. These may converge to form larger depressions termed gullies which carry greater amounts of water and larger particles. Large gullies, active only during or after rainfall, are termed ephemeral streams.

During overland flow (which follows the slope of the ground to the nearest watercourse) particles in transit may collide with and remove other particles in their path. If the rainfall is of short duration, entrained particles may not reach the stream (watercourse) but are deposited on areas adjacent to their source. These may ultimately reach a stream (watercourse) during subsequent storms.

1.1 INSTREAM EROSION

This refers to the widening or deepening of a stream channel by (a) corrasion - mechanical wearing by water and bedload materials (corrasion is the most significant method of in-stream erosion; (b) corrosion - dissolution and removal of particles through chemical action; (c) cavitation - due to high velocities around constrictions, e.g. bridges.

Streams with low banks, heavy vegetation, or rocky banks are resistant to corrasion from water. Channels may be deepened by corrasion - abrasive action of water and bedload materials. The deepening action may result in higher streambanks which

are then highly susceptible to undercutting and slumping through lateral action.

The sediment material carried by a stream (fluvial sediment) can be divided into (1) suspended load and (2) bedload. When the stream gradient and flow are reduced, sediments are deposited.

1.2 EFFECTS OF SEDIMENTS ON PHYSICAL/CHEMICAL QUALITY AND USE OF WATER

a) Sediments introduce nutrients, salts, metals, pesticides (which are adsorbed to the soil particles) into the aquatic environment. The finer sediment particles by virtue of their greater surface area would adsorb greater quantities compared to larger sediment particles.

b) Sediments lower the recreational and aesthetic value of the watercourse due to turbidity.

c) Sediments impair water quality for (1) agricultural use - may cause damage to water pumps, etc., (2) water treatment plants - such plants are designed to remove a certain amount of sediment. When this limit is exceeded, plant operations would be disrupted resulting in increased costs, etc.

d) Velocity drops within reservoirs may permit settling and filling in of such structures.

1.3 EFFECTS OF SEDIMENTS ON AQUATIC ORGANISMS

a) Fish spawning - fish eggs deposited on gravel beds depend on intragravel water flow to replenish oxygen supply and remove metabolic wastes produced by the embryo. Heavy sediment deposits could clog the gravel interstices and destroy this purifying mechanism.

b) Clogging of the gravel beds between hatching of the eggs and emergence of the young could be critical. This period requires adequate maintainence of intragravel flows, also sediments may form physical barriers preventing the emergence of the young into the stream.

c) Aquatic insects and other benthic organisms may be smothered by sediment deposits.

d) Suspended sediments can cause direct fish injury by abrasion of the gills. (Although the literature contains conflicting reports, the weight of evidence suggests that fish mortality will occur in prolonged exposure to very turbid waters.)

e) Suspended sediments produce turbid conditions which reduce primary productivity as a result of reduced light penetration. This results in less food for aquatic insects and consequently fish that feed on such insects will migrate to more productive areas.

f) High bedload could result in streambed scour and gravel shifting. This could displace fish eggs from within the gravel and/or crush the eggs against the gravel.

1.4 STREAM CHANNEL MODIFICATION

During the early stages in the formation of a stream, the force of water erodes the channel until a stable channel configuration is established. This configuration is determined by the velocity, quantities, etc. of water. In other words, a stable channel configuration is attained when water flowing within a stream establishes equilibrium with the channel. Often there is a difference in velocity of the flowing water from shore to mid-channel and from surface to bottom. Thus one side of a channel may be cutting while at the other side velocity may be so low that material will deposit. The deposition of material will result in shallower water depths, where abundant life forms may develop as the result of low velocity and greater light penetration. Oxbows along a streamcourse may exhibit similar characteristics.

Some of the more common activities resulting in stream channel modification are (1) changes in depth and width to increase streamflow (e.g. to provide flood relief) and (2) removal of sand and gravel for construction.

Modifications at one point along a stream would affect areas (ecosystems) upstream and downstream also.

1.4.1 Changes in Streambed

Fish spawning requires suitable substrate and current. Streambed changes may remove substrate diversity and alter current patterns. Example - dredging may destroy roughness and diversity of bed structure, consequently altering the current patterns.

1.4.2 Widening of a Stream

Removal of riparian vegetation may result in slumping of the streambank and formation of migrating berms within the channels.

Unstable banks around bridge approaches may continue to erode for sometime. Such areas require at least two years after construction to stabilize.

1.4.3 Increasing Channel Depth

Increasing channel depth usually results in changes in channel gradient and the stream will tend to re-establish equilibrium (see 1.4 above) resulting in upstream and downstream erosion.

If a streambed is deepened below an aquifer, the aquifer will be lowered. This may interfere with water supplies to wells and the flood plain may dry out. Without a reservoir to maintain low flow the stream may become a series of isolated pools.

1.4.4 Channel Straightening (Diversion)

Straightening of a channel will reduce the time of flow along the course. Reducing the time of flow without changes in velocity or turbulence, etc. will result in less time for waste assimilation and consequently the wastes normally entering downstream lakes or ponds may be less degraded (biologically).

Stream diversion may result in stream channel relocation in less permeable areas, resulting in reduced streambed infiltration rate and loss of pool-riffle ratios, spawning areas etc. Lining the channel with concrete etc. will tend to have similar effects. The construction activities related to relocation often produce excessive turbidity, the new channel would be continuously reworked until a stable configuration is attained. This reworking of the new channel will also produce excessive amounts of sediment which may impair existing uses in downstream reaches.

1.4.5 Sand and Gravel Removal

a) Results in changes in channel gradient and bed contour.

b) May form deep holes where water may stagnate and anaerobic conditions may result. This could result in the release of toxic substances and elimination of aquatic life.

1.4.6 Removal of Streambank Vegetation

a) Tend to increase water temperatures due to direct solar radiation.
b) Leaf fall is an important energy source to the food chain and aquatic species vary in their preference for leaf type.
c) Terrestrial insects that fall into the water from overhanging vegetation would be eliminated as a source of fish food.
d) Removal of streambank vegetation reduces the frictional resistance of the bank against the erosive force of water, thus increasing erosion potential.

1.5 STRUCTURAL MODIFICATIONS

This refers to the use of revetments, retaining walls, rip-rap etc. to protect slumping streambanks or banks subjected to high velocities. Such areas include sharp bends in a streamcourse, constrictions around bridges and opposite banks where one stream enters another. Structures used for bank protection usually provide blanket cover for the bank by rocks or cement slabs, concrete mattresses, grout-filled bags etc.

Recommendations for structural modifications -

a) The area should be properly aligned and graded to stable slopes and well compacted.

b) The proposed structure should be designed to withstand the pressures of flow and be safe against damage by ice, floating debris and frost action.

c) The structure should be sufficiently tight to prevent leaching of the underlying soil materials.

d) The structure should be flexible enough to conform to irregularities in the bank and later settling of the foundation.

e) The structure should be permanent, i.e. the structure should be built as a permanent solution to the problem it is designed to solve.

f) Work should be done during low flow periods and in some instances work may require use of cofferdams, etc. Operations in recreational areas should be timed so as not to unduly interfere with recreational uses.

g) No cement or lime should be allow to enter the watercourse.

h) Construction debris should be collected and disposed of in an approved landfill site.

i) The ends of the structure should be secured within stable areas adjacent to the area to be protected.

j) Adequate toe protection beyond the anticipated scour line should be provided.

2. SWAMPS

Usually refer to relatively flat water-logged or drowned lands characterized by tall grasses and shrubs.

a) They are capable of absorbing large amounts of water thus preventing flooding of adjacent lands and downstream reaches.

b) There are usually no appreciable currents in swamps. As a result sediments drop out and waters are of high clarity, oxygen levels are satisfactory because of photosynthetic production of oxygen and abundant aquatic life exists.

c) Usually because of their inaccessibility they form ideal habitats for breeding and feeding for a variety of species, including migratory birds and rare or endangered wildlife.

d) They absorb and permanently store a great deal of nutrients, thus improving water quality of the receiving stream or adjacent watercourse.

e) The organic detritus of marshes is an important energy source to the downstream food chain.

f) Swamps are very sensitive to alterations such as channelization, dredging, filling, etc. These areas should be left intact wherever possible.

3. SHORELAND - URBAN DEVELOPMENT

This refers to construction of housing units, subdivision development, industrial development, waterfront developments, etc.

This type of activity usually involves a variety of operations which may encompass topics mentioned in other sections of this booklet.

3.1 EFFECTS

Large scale urban construction projects involve a variety of unit operations which must be evaluated independently, although it must be remembered that the effects produced from the project as a whole are greater than the sum of the individual unit operations. Thus, for example, while evaluation must take into account the effects of sediments produced from cuts and fills on the aquatic environment, consideration has to be given to the combined (synergistic) effects of sediments, possible oil spills from construction machinery, toxicity of construction chemicals etc. The major problems encounterd in shoreland-urban development are those of erosion-sedimentation resulting from mass grading which leaves large areas of bare soil exposed for considerable lengths of time, unprotected cuts and fills and stream fording.

3.2 EVALUATION

Proposals for construction activities should include maps, written description and plans describing the following:

a) Location of the site in relation to adjacent watercourses, (drainage patterns).

b) Water uses within the adjacent watercourses.

c) Extent of cuts and fills (e.g. dimensions, amounts of material to be placed or removed, grade of slope, etc.)

d) Source (e.g. gravel pit, other construction site, etc.), type (e.g. rubble and sand, clean sand, gravel, etc.), and location of stockpiles for fill material.

e) Proposed stream diversions or alterations

f) Grading plan - construction procedures and sequence

g) Location of wells, sanitary facilities, etc.

h) Method of stream crossing (e.g. using a bridge, fording, etc.)

Additional information required is listed in Appendix A (information required for environmental assessment).

3.3 RECOMMENDATIONS

a) Construction procedures and sequence should be planned so that work that could lead to severe erosion be done during dry weather. In instances where this is not possible or applicable, precautions must be taken to i) minimize erosion by mulching exposed soil ii) providing means of retaining sediments such as desilting basins (see guidelines on desilting basins).

b) In areas where the project abutts a watercourse, a patch (e.g. 5 to 25 feet depending upon bank size, shape, etc.) of vegetation should be left intact between the project area and the watercourse. This patch should be wide enough to prevent bank failure and trap sediments.

c) Access roads to the site should be clearly defined and have all-weather surfaces. Use of heavy construction machinery should be restricted to the inner perimeter of the site. Efforts should be made to site access roads for permanent use.

d) Interim sanitary waste collection and treatment facilities must be provided during the construction period. All trash must be collected and disposed of in approved landfills.

e) Stream crossings should be confined to as few sites as possible and should be done via bridges or culverts.

f) On-site machinery maintenance including cleaning of cement trucks must be done in specially designated areas provided with facilities to retain soils, solids, etc. These wastewaters must be adequately treated prior to disposal.

g) Use of herbicides, pesticides, defoliants, etc. requires proper permit and supervision.

h) The beds of all watercourses must be cleared of any materials resulting from construction.

i) All abandoned roads and areas bared during construction must be scarified, seeded and mulched upon completion of the project.

3.4 COMMENTS

Each construction proposal should be evaluated on an individual basis and many would require site-specific recommendations to minimize possible impacts. It is therefore recommended that site evaluation be an integral part of the overall assessment.

4. MARINAS AND COTTAGES

This refers to construction activities associated with commercial or private development related to water-based recreation. The following points are in addition to construction guidelines mentioned in other sections of this document.

Assessment

a) Suitability of soil for septic tanks, level of water table, etc.

b) Holding tanks and treatment facilities for watercraft wastes.

c) Disruption of marsh or aquatic ecosystem-dredging, draining, filling.

d) Water use conflicts - recreation, water supply, flood control, etc.

e) Waste discharges - organics, nutrients, salts, metals, solids, bacteria, treated wastes that may affect water temperature and use.

f) Impact of development on water quality (fuelling spills, etc.).

g) Bacteriological quality of areas used for total body contact.

h) Capacity of the area for additional boats.

5. REMEDIAL DREDGING PROJECTS

This covers dredging projects undertaken by riparian property owners to improve the nearshore areas adjacent to their property.

a) No work should be conducted during the peak recreational season (June, July and August) if such work will unduly interfere with recreation.

b) Work should not result in water quality impairment that would affect nearby water uses.

c) Equipment, methods and procedures should be selected so as to minimize turbidity during dredging operations.

d) Once the project has commenced, it should be completed as soon as possible.

e) Spoils should be deposited on adequate land disposal sites above the high water mark (i.e. so that the spoil material will not regain access to the watercourse). The spoils should be stabilized as soon as possible to prevent erosion.

f) All debris (uprooted plants, wood, etc.) should be contained in the immediate work area and placed on shore.

g) Critical habitat (e.g. marshes, spawning grounds, etc.) areas should be left undisturbed.

h) Work on Crown land requires an Ontario Ministry of Natural Resources permit.

6. MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL, INDUSTRIAL PLANTS, POWER GENERATING PLANTS, ETC. INTAKES AND OUTFALLS

6.1 EVALUATION

a) Interim (construction) water intake and permanent intake.

- i Materials (e.g. a 20-inch diameter steel pipe backfilled with gravel, etc.) and methods (e.g. trench excavation by blasting and material removal with a backhoe, etc.) of construction.
- ii Quantity, type (e.g. overburden consisting of organics, muck, wood debris, sand with high oil and grease content, etc.) and method (e.g. to be trucked to landfill site, to be barged for deep water disposal, etc.) of disposal of excavated material.
- iii Dimensions of the structure.
- iv Timing and duration of construction (e.g. during fall season, October 3 to 15).
- v Shoreline modifications (e.g. a mound on the shoreline will be graded and levelled or a break in the shoreline will be filled in etc.).
- vi Quantity and type of backfill material.
- vii Water depth at the terminal of the structure (depth contours).
- viii Quantity of water withdrawals (NB: withdrawals of 10,000 gal/day and over require an Ontario Ministry of the Environment permit).

b) Outfalls - interim construction drains and permanent outfalls. In addition to (i) to (vii) above information on the quality and quantity of waste from outfalls must be provided.

6.2 RECOMMENDATIONS

- i Relation of outfall to intakes should be such as to prevent recirculation of discharge water, especially with regards to sewage outfalls and water intakes, cooling water intakes and treated discharges, etc.).
- ii Structures should not be placed in spawning areas or fish migratory routes.

iii Structures should not be located in natural breaks (e.g. a bay, cove, etc.) in the shoreline - such areas may act to trap fish and may experience reduced circulation with the main watercourse.

iv Design outfall velocity should be such that no bottom scouring will occur.

v The outfall or intake structure should be designed so that flows will not be restricted by ice conditions and the structure would safely withstand ice pressures.

vi Design intake velocity should take into consideration entrainment of fish or other aquatic organism. Fish bypass, etc. should be provided where necessary.

7. DESILTING BASINS

The major function of a desilting basin is to remove suspended soil particles from runoff water from land being developed. They are very useful in areas where the soil surface is disturbed (through construction, etc.) and the natural infiltration capacity of the soil is reduced. Desilting basins provide settling, infiltration to ground water and outflow of water of acceptable quality to natural channels. Acceptable quality is considered quality not lower (refer to Guidelines and Criteria to Water Quality Management in Ontario) than that in the natural receiving watercourse.

Desilting basins should be used where runoff containing solids may affect water quality and use.

2.1 PRELIMINARY PLANNING CONSIDERATIONS

a) Final basin size and location should be preceded by adequate surface and subsurface investigations (soil tests, stability analyses, infiltration characteristics, local ground water uses, etc.), runoff computation, peak flows, etc.

b) The basin should be in operation as soon as construction starts or the soil is disturbed.

c) Inflow channels and basin dimensions should be based on peak flow quantities. The capacity of the basin should be such that it would safely contain peak flow volumes without overflow.

d) The basin should be located as close as possible to the proposed construction area. This would reduce the need for long transmission channels which could add to the sediment sources.

7.2 CONSTRUCTION CONSIDERATIONS

a) The entire pond and embankment area should normally be cleared and grubbed and the excavated material should be used in protected fills, i.e. incorporated within the core of a fill that is armoured against erosion.

b) Dyke construction must be closely supervised to ensure proper selection and placement of fill material, moisture content and compaction. Organic material such as peat, silt, grass or wood, etc. should not be incorporated into the embankment.

c) All topsoil must be removed and a proper foundation prepared before placing fill. Selection should be such that the most impervious material is placed in the centre of the embankment. Soft spots, etc. must be excavated to a depth that would allow the base to adequately support the embankment load.

d) Topsoil material stockpiled for later use must be protected against erosion by vegetative cover.

e) The inlet structures leading the the basin should be protected against erosion and when necessary incoming velocities should be reduced to protect the basin from scour. Protection against scour can be achieved by avoiding excessive gradients for inflow structures and providing energy dissipators (such as riprap) when necessary.

f) In cases where the inflow contains large amounts of colloidal material, it may require chemical treatment (e.g. flocculation, etc.) to induce settling.

g) Outlet channels should be designed to safely carry maximum anticipated flows with vegetative or structural measures (riprap, etc.) to protect against erosion and scouring.

h) The entrance to the outlet channel should be baffled to prevent floating debris (wood, etc.) from entering the channel. Accumulated debris should be removed periodically and adequately disposed of in such a manner that the material would not enter any watercourse or contribute to litter. This may require use of authorized sanitary landfill sites.

i) The outlet from the basin should be provided with adjustable weirs to provide adequate water quality control through extended retention periods and regulate outflow to levels acceptable in receiving watercourse.

j) Where the outlet channel enters a watercourse, provisions must be made to ensure that local scouring or turbidity generation does not occur. This may require energy dissipators or drop structures. (See Diagram 7-A).

k) The discharge rate and volume to a watercourse should not cause the watercourse to exceed its maximum carrying capacity or to cause local flooding.

l) The quality of the effluent from the desilting basin after complete mixing should not be lower than the upstream quality in the receiving watercourse.

m) Sanitary, domestic and industrial wastes should not be permitted to enter the basin or its channels.

7.3 EARTH-FILL TYPE DAMS DOWNSTREAM FROM DEVELOPMENT AREA

These structures are usually temporary structures designed to trap sediment during the construction period and are removed once stability in the development area is attained. (See also Section 17).

a) The structure should not block or impede the passage of migratory fish or other types of wildlife or cause diminution of water quality or quantity.

b) Provision should be made to ensure that normal streamflow is maintained during the operational phase of the structure.

c) The installation should be properly stabilized to prevent erosion of the fill or structural failure. The design feature should be such that adequate settling could be achieved without upstream flooding during peak runoff periods.

d) Construction sequence* and procedure** and type of fill material (see Diagram 7-B) used should be chosen to cause the minimum possible increase in stream sediment load and adjacent streambed disruption.

e) The proponent must provide water of equal quality and quantity to normal supplies to downstream water users in the event of water quality impairment resulting from the project.

f) The accumulated sediment should be mechanically removed as the storage space behind the dams becomes filled. This material should be placed in protected fills.

g) After the development area has attained stability or the structure has served its useful life, the entire structure should be removed. Removal procedures and sequence (e.g. to correspond with low flow periods) should be planned so as to cause the minimum possible turbidity or loss of material. Removal plans should include adequate onshore disposal of material and the streambed should be restored as much as possible to its original condition or be contoured for the benefit of aquatic organisms.

**Sequence*-refers to the order of operations and may for example be as follows:*

1. *have sufficient amount of fill material on hand*
2. *reducing upstream flow*
3. *prepare foundation for the dam*
4. *place fill material and install sluice, grade or compact fill, etc.*
5. *place riprap on upstream slope of dam.*

***Procedure*-refers to the method of performing the operation. The idea is to choose the right tool for the particular job. For example, it may be easier to push a large amount of fill into the watercourse with a large bulldozer without being able to adequately control loss of fill material. This loss may be greatly reduced using a smaller bulldozer or front loader for example. Placing riprap on the upstream slope of the dam by hand may result in a smaller loss of fill than dumped rock, etc.*

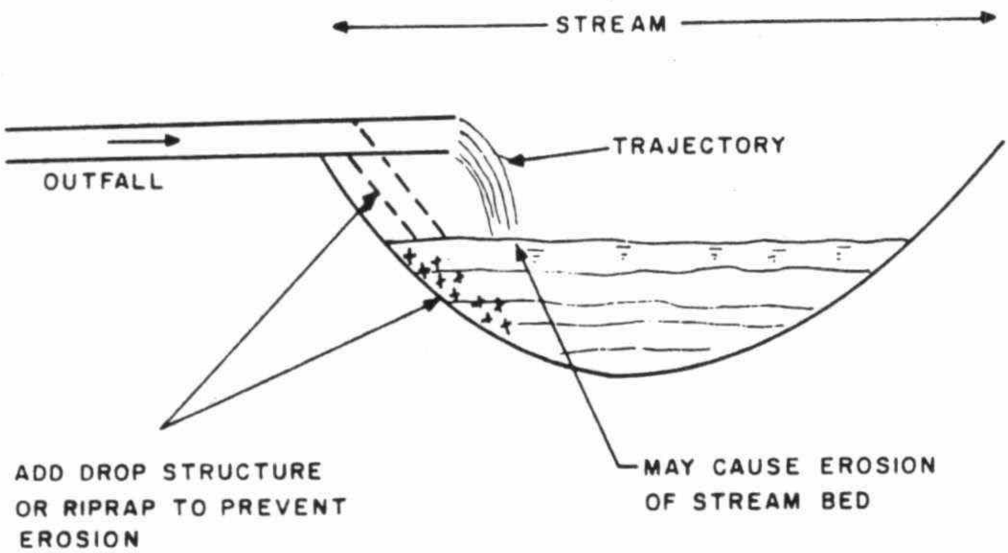
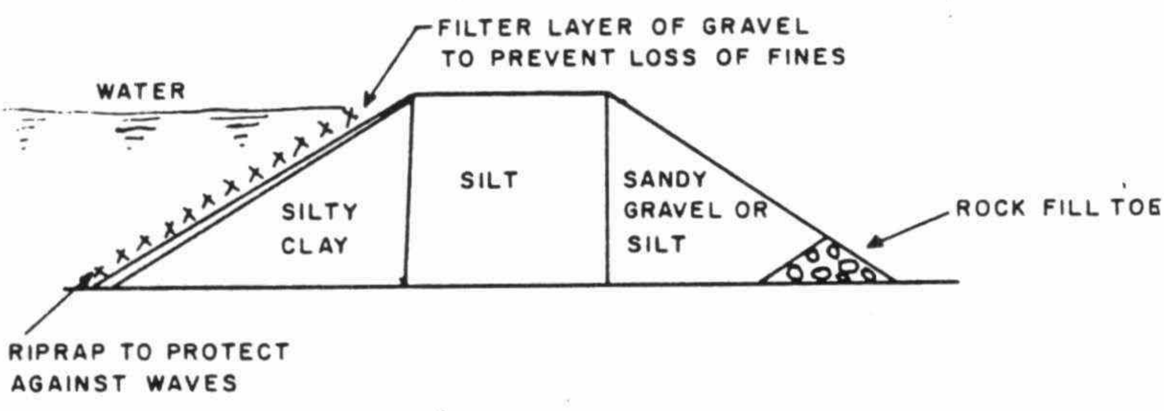


DIAGRAM 7-A



EXAMPLE OF "TYPE" OF FILL MATERIAL

DIAGRAM 7-B

8. ROAD CONSTRUCTION

Refers to the construction of highways, arterial roads, maintenance, etc.

8.1 EFFECTS

1. Cuts and fills on steep slopes could contribute to considerable erosion and sedimentation of adjacent watercourses.

2. Removal of vegetation for road construction, especially along stream banks, could increase stream temperature and streambank soil erodibility. Removal of streambank vegetation also reduces friction to water flows, consequently, channel resistance to flood flow is reduced. This may lead to bank erosion and sloughing. Removal of vegetation on steep slopes leads to rapid erosion and sloughing.

3. A newly constructed highway takes at least two years to stabilize. Improper interim erosion control could lead to erosion.

4. Considerable sedimentation may result from sand and gravel washing and newly placed embankments.

5. Use of sheet piling to support excavation walls and embankments could block the movement of ground water.

6. Roads to be built on steep slopes usually require extensive cuts to maintain suitable grades. If these cuts extend through aquifers they could severely disrupt ground water flow.

8.1 RECOMMENDATIONS

The following points may be considered aids in evaluating road construction projects. The headings appear in the usual sequence of operations encountered during road construction.

8.2.1 Initial Clearing of Right-of-Way

a. Avoid disturbing low cover vegetation for as long as possible to protect soil.

b. All debris and soil generated from clearing should be located away from watercourse(s).

c. In areas deemed sensitive to fish, proposals to remove bank cover vegetation should be closely co-ordinated with Ontario Ministry of Natural Resources or other appropriate agencies.

8.2.2 Open Cuts

a. Provisions should be made for needed drainage and diversion works at the top of and within the cuts. Adequate toe support (e.g. cribbing, etc.) should be provided where required (see Diagram 8-2).

b. Local conditions (soil, topography, etc.) should determine the grade of the slopes.

c. Terracing should be undertaken where necessary to prevent erosion.

d. The disturbed area should be mulched and revegetated as soon as possible.

e. Large cuts may interfere with ground water quality and/or quantity. This could pose severe problems in areas where the supply of water is from wells.

8.2.3 Fill Areas

a. The fill areas should be protected against erosion by prevailing drainage patterns. Drainage on the fill-proper should be controlled to prevent surface erosion.

b. Adequate toe support for fills should be installed to prevent sloughing and subsequent erosion.

c. No excess fill material should be left where it will be subject to erosion.

d. All bare soil surfaces should be stabilized as soon as possible.

8.3.4 Stream Channel Relocation and Excavation

a. Rechannelling should be avoided as much as possible if rechannelling is necessary.

   i Relocation should result in the minimum possible changes in stream length and gradient.
   ii A solid bottom location should be chosen or precautions taken against scour.
   iii The new channel should not cause any significant cutting, meandering or reworking of old deposits.

b. Ontario Ministry of Natural Resources or other appropriate agencies should be consulted with regards to a suitable time for construction so as not to interfere with fish activities in the area.

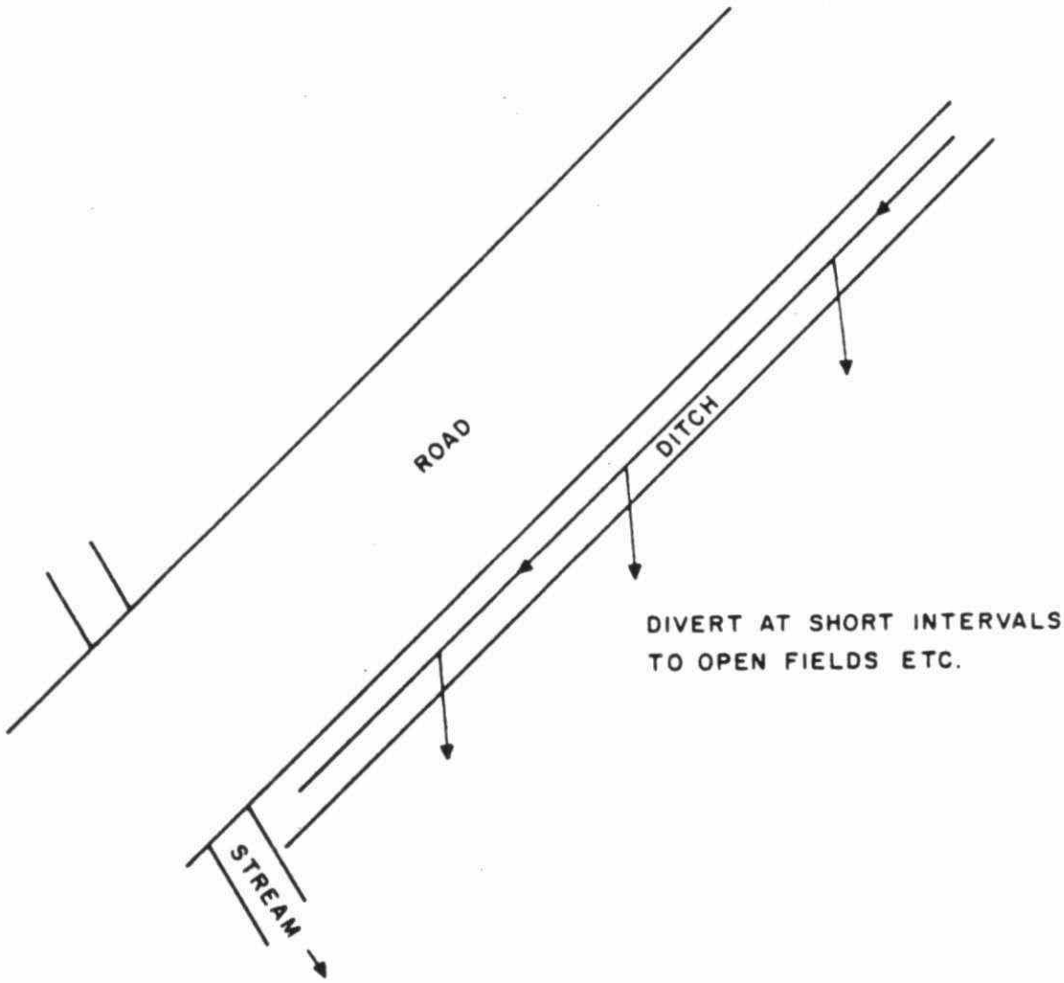


DIAGRAM 8-1

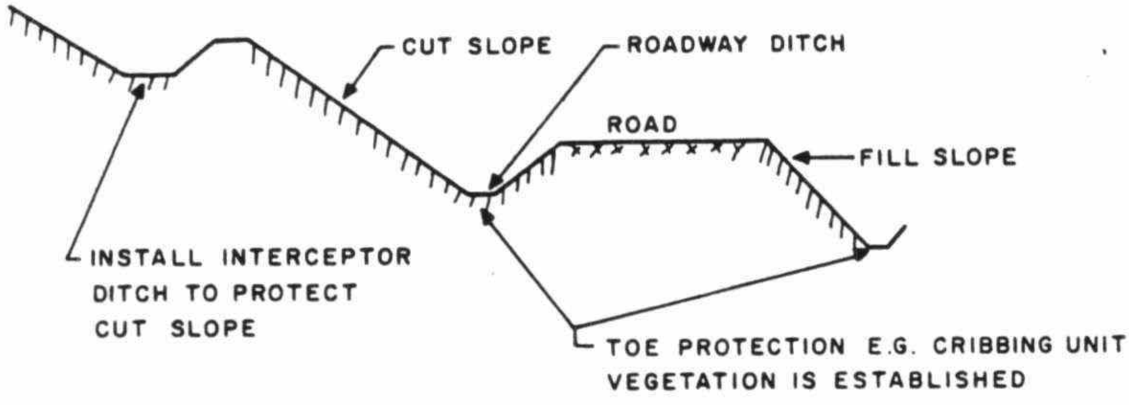


DIAGRAM 8-2

c. Provisions should be made to leave, where feasible, a path of vegetation to act as a buffer between the road and channel.

d. Relocation should be done through dry construction. The channel of the new stream (including slope protection) must be completed before the old stream is diverted to the new and then the old stream may be blocked off.

e. Where the old channel is left open, measures should be required to prevent stagnant or nuisance conditions from developing.

f. The new channel design should convey base flow and accommodate peak flow without sustaining damage.

g. Use of heavy construction machinery on streambeds or streambanks should be minimized.

h. Except for identified areas where streams are being modified to enhance existing conditions the streambed should be restored to its preconstruction configuration upon completion of the work.

8.4.5 Drainage Ditches

a. Ditch cuts should be made on regular grade (i.e. do not make excessively large cuts, try to follow the natural contour as much as possible, see Diagram 8-2) and the minimum design should accommodate peak runoff conditions.

b. Care should be taken to ensure that the side slopes of the ditches are not undercut and the walls should be properly lined for erosion protection.

c. Provisions should be made to divert accumulated drainage at short intervals (distance) into natural channels, infiltration ditches, settling ponds or permeable ground cover depending on quality of runoff (see Diagram 8-1).

8.5.6 Culvert Installation

a. Such installation should be made on existing natural grade with minimum possible disturbance to the channel and the culvert should project well beyond the fill area.

b. The inlet and outlet of the culvert should be protected against erosion.

c. Culvert design features should be such that the slope of the culvert and resultant velocity change would be compatible with streambed material. The invert elevation shall be set to ensure adequate water depth for fish at low flow periods.

d. The culvert should not restrict peak flow or fish migration. Baffles or other auxillary protective devices should be installed where necessary.

8.6.7 Surface Shaping

a) The road surface should be carefully outsloped and graded so as to minimize need for drainage structures and to minimize erosion.

b) Construction sequence should be planned to avoid reworking and rutting the sub-base.

c) Where surface drainage is collected on slopes appropriate structures (e.g. chute, pipe, etc.) should be provided to prevent erosion of the slope by runoff water.

d) Pavement construction should not result in stream contamination by such materials as lime, cement, oils, asphalt, etc.

8.7 FINAL STABILIZATION

a) Upon completion of the project any material (from temporary fills, culverts, refuse, etc.) deposited inadvertently should be removed from the streambed and placed onshore such that it will not re-enter the watercourse.

b) All exposed soil should be mulched and revegetated.

9. BRIDGE CONSTRUCTION

9.1 CLEARING AND SITE PREPARATION

a) Disturbance of soil cover should not exceed the minimum area required for construction.

b) Debris and soil removed should be located away from the watercourse and stabilized against erosion.

c) Disturbed areas should not be left exposed for long periods of time without adequate erosion protection.

d) All fill material should be stockpiled away from the watercourse and be protected against erosion.

9.2 CONSTRUCTION PROECEDURES AND SEQUENCE

Construction procedures and sequence should be planned:

a) To cause minimum disturbance to fish activities.

b) To avoid interference with the peak recreational season (June, July and August) in heavily used areas.

c) To cause no significant diminution in quantity and quality of water for nearby uses.

9.3 CHANNEL EXCAVATION AND ALTERATION

a) Fine or loose material removed from the stream bed should be disposed of on land so that it will not regain access to the watercourse.

b) To avoid degradation of water quality, laying of bridge foundation, channel alterations, etc. should be done in the dry or should be done with protective dykes or cofferdams.

c) Constriction of flow due to construction should not produce any appreciable backwater (the stream should be able to convey minimum flow and accommodate peak flows).

d) In instances of skew crossings where the abutments may redirect flow to the opposite banks, proper armouring of the banks must be undertaken.

e) The river width constriction and resultant velocity of the water should be compatible with streambed material to prevent erosion or other undesirable conditions.

9.4 INTERIM STRUCTURES

a) These structures should not impede flow or restrict passage of migrating fish.

b) They should not cause any significant erosion to streambed or banks or in the case of fills be eroded themselves.

c) They must be removed upon completion of the project, and the area restored to its original (or better) condition.

9.5 CONSTRUCTION

a) Use of heavy construction machinery on streambed or streambank should be held to the minimum possible. Where repeated crossings are necessary, temporary bridging should be provided or the ford protected with stone.

b) Provisions should be made to redirect runoff from fill and disturbed areas to side ditches where sediment traps can be provided if necessary.

c) Only clean fill (material free of fines, industrial pollutants-oil, grease, etc.) should be incorporated in the abutments. Backfill below the highwater line around piers and abutment should be clean, granular material that will not be eroded.

d) Embankment slopes, created during construction, that encroach on stream channel should be adequately protected against erosion.

e) All ditches, fills, or other exposed soil should be mulched and revegetated as soon as is practically possible after construction.

f) Shaping of bridge surface should not result in stream contamination by such materials as lime, cement, asphalt, etc.

g) Precaution should be taken to ensure that paint does not enter the watercourse.

h) Upon completion of the project any material (from temporary fill, culverts, refuse, etc.) deposited inadvertently should be removed from the streambed and placed onshore such that it will not re-enter the waterway.

10. SUB-AQUEOUS MINING

This term generally refers to the removal of sand and/or gravel from the bed of a watercourse or the removal of beach material.

10.1 EFFECTS

a) Excavation could generate a significant degree of turbidity which may pose problems for water intake systems and actual disruption or siltation of adjacent areas may result in the loss of important aquatic habitats.

b) Removal of a source of beach feeding material could induce shoreline erosion and may result in the loss or degradation of important recreational areas.

f) Excavation may create deep holes where stagnant water conditions could occur.

10.2 RECOMMENDATIONS

a) In areas adjacent to water intakes, etc. work should be done in close co-operation with the water user.

b) Current patterns should be used advantageously to carry turbidity away from recreational areas or water intake systems.

c) In recreational areas work should not be conducted during peak use period (usually June, July and August).

11. SURFACE MINING

Surface mining, as opposed to underground mining, refers to such methods as strip mining, open-pit mining, hydraulic mining, etc. Strip mining is often used with reference to coal mining, where large amounts of overburden are removed to expose the underlying material to be extracted. The method of onland mining for minerals is often referred to as open-pit mining. The minerals are usually found relatively close to the surface and compared to strip mining only a small amount of overburden has to be removed. Open-pit mining results in a large open hole in the ground. The "waste products" are usually discharged in a specially designed "tailings area" and the overburden is stockpiled in areas adjacent to the pit. Quarries (mining of gravel for building products) is a form of open-pit mine.

11.1 EFFECTS

The major forms of pollution resulting from surface mining may be broadly classified as chemical and physical pollution.

Physical pollution arises primarily from sediments resulting from increased erosion after the land has been disturbed. Chemical pollution covers such forms as increased trace metal concentrations and acid formation from oxidation of leached minerals. These forms of pollution usually start during the initial stages of mining and continue long after the mine has been abandoned unless adequate control measures are undertaken.

Most control methods centre around the control of "water" to the site. Reducing the inflow of both surface runoff and ground water to the mine pit or waste areas (where leaching and erosion can occur) would greatly reduce the damage to adjacent watercourses. In order to minimize acid drainage from tailings area, chemical treatment (e.g. neutralization with lime) may be required.

The inflow of surface runoff to the mine site may be eliminated by dyking, ditching, use of flumes, etc. to channel water away from pollutant bearing materials. Most metals occur in the sulfide form which is relatively insoluble in water but upon oxidation to the sulfate form they become readily soluble. Other forms of pollution such as radioactivity from uranium mill tailings may be carried by wind or runoff into a watercourse where they continue to decay releasing radioactivity.

Under natural conditions sulfide minerals undergo very slow oxidation due to the small amounts of oxygen diffusing through the soil and in other areas the mineral may be inundated by ground water which usually contain low amounts

of oxygen (usually $\leq$ 10 mg/l). Mining results in the sudden exposure of large quantities of sulfide minerals to the atmosphere and rapid oxidation takes place.

Mine tailings discharged into a tailings pond and inundated by water undergo slow oxidation because less oxygen is available compared to direct exposure to the atmosphere. Advocates of open water disposal for tailings must be cautioned that inundation by water does not stop the oxidation process.

In deep areas of a lake, which may already be experiencing low dissolved oxygen concentrations, tailings wastes will further reduce the dissolved oxygen levels.

Thus, besides the immediate impact such as turbidity, immediate release of chemical pollutants (e.g. trace metals, sulfates, etc.) and the loss of bottom habitat, the slow rate of oxidation of tailings material would continue for a long time.

11.2 RECOMMENDATIONS

a) Obtain adequate information on the proposed site (see Appendix A for information required).

b) All access routes (roads, power lines, water lines, etc.) should be clearly defined. Access roads should be sited for permanent use.

c) Use of pesticides, herbicides or defoliants to control biting insects or remove vegetation requires proper permit and supervision.

d) Surface water runoff to the mine site should be intercepted by placing impervious barriers (dykes) around the mine site providing underdrains, using ditches, flumes, etc. to channel the water away from the mine site.

e) Material, relatively free of pollutants, should be available to form the upper layer of regraded surfaces.

f) Preventive measures to minimize the amounts of sediments reaching a watercourse should be undertaken. These may include - diversion channels, desilting basins, soil compaction, vegetation cover, etc.

g) The mining operation should not cut into ground water recharge areas. If this cannot be avoided, ground water should be intercepted and diverted away from the pit. This may require pumping of the water or sealing a portion of the pit, grout curtains, recirculation, etc.

h) Potential highly erodible soils should be protected against erosion by special control measures (e.g. mulch, compaction, etc.).

i) All material stockpiles should be adequately protected against erosion to prevent material from entering any watercourse.

11.3 TAILINGS, WASTEWATER AND DEWATERED WASTES

a) Efforts should be made to avoid using natural watercourses for tailings disposal.

b) The tailings disposal area should be adequately dyked off to prevent the escape of polluting materials to adjacent areas.

c) The minimum setback of the site from existing watercourses prescribed by Ontario Ministry of Natural Resources should be adhered to. (Consult with MNR-Industrial Minerals Section to determine where this requirement exists.)

d) Efforts should be made to reduce the quantity of waste water (e.g. reuse decant water) as much as possible.

e) Discharge of water from the tailings area to natural watercourses should be regulated according to the waste assimilation or dilution capacity of the receiving watercourse(s) for given streamflows.

f) If discharge water of acceptable quality cannot be achieved by physical settling alone, additional treatment (e.g. chemical) or a combination of treatments should be undertaken. This may be necessitated by seasonal fluctuations in use, quantity and/or quality of the receiving water.

11.4 DYKES AND TAILINGS POND

A containment area for tailings disposal should provide retention of solids and contaminants so that these materials will not enter any watercourse or cause detriment to adjacent areas.

11.4.1 <u>Preliminary Considerations</u>

a) Any area selected as a potential tailings disposal area should be thoroughly investigated for compatability with existing and proposed uses.

b) Dyke design should be based on adequate soil, subsurface and stability analyses.

c) Dyke design and construction should be such that the dyke is safe and stable under all construction and operational phases of the tailings disposal area.

d) Tailings disposal areas to be built on marshy or other wetland areas should be fully approved by the Ontario Ministry of Natural Resources or other appropriate agencies.

e) Where necessary prior approval must be guaranteed the proponent with regards to easement access or use of waterlots.

f) In areas where dyke failure could result in severe damage to neighbouring property, etc., precautionary measures should be formulated well ahead of the actual disposal operation to deal with any emergency.

11.4.2 Capacity Considerations

a) The dykes and dyked area should be constructed such that at any given time it will provide sufficient settling time to reduce suspended particulate matter to acceptable levels.

b) Provisions should be made for foundation and embankment settlement to allow adequate freeboard and prevent over-topping by waves.

11.4.3 Design and Construction Considerations

a) Trees, stumps, etc. in the path of the dykes should be cleared and grubbed. The subsurface conditions should indicate the need for overburden or organic material removal. The removal of overburden is necessary to ensure a solid footing or foundation for the dyke.

b) Access roads should be clearly defined and adjacent areas should not be subjected to unnecessary traffic or trampling.

c) The design features of the dyke must be such that it will not impose excessive stresses upon the foundation.

d) The slopes of the dykes must be stable under all construction and operational conditions. Where necessary the inner wall of the dyke should be protected against wave action.

e) Dyke designs should incorporate features that would minimize possible failures due to sinking or spreading.

f) Dykes built on shore close to rivers or streams should be located such that they will not result in lateral displacement of the river or streambank.

g) The dyke or containment area built into a stream should not restrict natural streamflow to the degree that upstream water levels will be raised or back water created or migratory paths blocked.

h) The use of heavy construction machinery should be restricted as much as possible to areas directly associated with the project.

11.4.4 Operational Considerations

a) The inflow end of the tailings discharge should be located such that incoming material would not cause local scour of dyke or buildup of material near the outflow area.

b) The outlet sluice should be located so that there will be no short-circuiting of flow from the inlet.

11.4.5 Effluent Quality Considerations

a) If possible adjustable weirs should be used instead of simple outfall pipes to provide adequate detention time and water quality control.

b) Where feasible a layer of lowcover vegetation should be left intact between the outfall and receiving watercourse to provide additional entrapment of particles.

c) In instances where the water within the containment area contains debris or surface films, skimming devices should be installed in the discharge area. Where necessary to guarantee effluent of acceptable quality, the containment area must be provided with multiple settling basins.

d) In cases where the effluent from the outfall leads to a ditch prior to the watercourse proper, the ditch should be protected as necessary to prevent scouring and turbidity.

e) Consideration should be given to the use of additional treatment methods, such as chemical coagulation where conventional settling procedures are not adequate.

f) Water quality of the effluent shall be such that the Ministry of the Environment's published permissible criteria for receiving stream are not violated. (Guidelines and criteria for water quality management in Ontario.)

11.4.6 Maintenance Considerations

a) The passage of seepage flow through the dyke and foundation must be controlled, so that piping, sloughing and the removal of material by solution do not occur.

b) Measures must be taken to stabilize the following conditions: - cracks in slopes, bulging and slumping on slopes, excessive pore pressure, wet spots and seepage on outer slope, erosion of slope protection, excessive settlement and horizontal movement.

c) Where simple outfall pipes are used measures such as installation of trash screens must be taken to ensure that they do not become plugged.

d) The faces of all slopes should be properly protected by vegetative cover, berms, riprap, etc.

12. MARINE CONSTRUCTION GUIDELINES

12.1 DREDGING

Each proposal to dredge will be reviewed for its water quality implications with consideration being given to the following factors:

a) Physical, chemical and biological quality of material to be dredged.
b) Quantity of material to be dredged.
c) Location and dredging site in relation to other water users (including fish and wildlife habitat).
d) Physical characteristics of the watercourse, such as depth and currents.
e) Time of year.
f) Duration of dredging.
g) Type of equipment to be used in dredging.
h) Existing quality of water in the vicinity of the dredging site.
i) Frequency of maintenance dredging.

12.2 SPOILS DISPOSAL IN OPEN WATER

Each proposal for open water disposal of dredged spoils will be reviewed for its water quality and use implications with consideration being given to the following factors:

a) Physical, chemical and biological quality of the dredged spoils.
b) Quantity of the dredged spoils.
c) Location of the disposal site in relation to other water users (including fish and wildlife).
d) Physical characteristics of the watercourse at the disposal site such as depth and currents.
e) Existing and potential quality and use of the water in the disposal area.
f) Existing quality of the sediments in the disposal area.
g) Type of equipment to be used in transporting the spoils to the disposal area and method of depositon of the spoils.
h) Duration of disposal operations.
i) Frequency of use of disposal site.
j) Past history of spoils in the area.
k) Time of year.

12.3 PARAMETER LEVELS

The following parameter levels (given in % dry weight and mg/g are used as guidelines* to suggest that contamination of the material to be dredged has occurred.

Parameter	Levels % Dry Wt.	mg/g
Percent loss on ignition at 600^{o}C (Organic Content)	6.0	
Chemical Oxygen Demand (COD)	5.0	50
Total Kjeldahl Nitrogen (as N)	0.2	2
Total Phosphorus (as P)	0.1	1
Oil and Grease (ether or chloroform solubles)	0.15	1.5
Total Mercury	0.00003	0.3 ug/g

*These guidelines are continually reviewed in the light of data being obtained from dredging projects on water quality and water use effects and in light of new information in the literature.

Even though sediments may have concentrations of the parameters lower than the stated guidelines, they may be deemed unsuitable for open water disposal on the basis of one or more of the following tests: settleability, sulphides, trace metals (including but not limited to iron, cadmium, lead, copper, zinc, chromium, arsenic, and nickel), pesticides and bioassay test for toxicity. Conversely, sediment with higher levels may be suitable for open water disposal in some circumstances. Since sediment quality is only one factor considered in spoils disposal. It is possible that dredged material meeting all of the above quality requirements will be rejected for open water disposal based on review of the other factors outlined previously in Section 12-2.

12.4 SPOILS DISPOSAL ON LAND OR IN DYKED AREAS

Each proposal to dispose of dredged spoils on land or in dyked areas will be reviewed for its water quality implications with consideration being given to the following factors:

a) Adequacy of dyked structure to contain spoils under forces of lateral pressure, seepage, and/or erosion. (This does not imply that the Ministry is responsible for the structural integrity of dykes, etc.).
b) The quality and quantity of any supernatant draining to a watercourse.
c) Adequancy of native soils for containment of contaminants (including protection of ground water quality).

In some instances, treatment of the supernatant from a disposal area may be required. This treatment could be physical (settling or filtration), chemical (coagulation and flocculation or precipitation), biological (activated sludge), or a combination of these.

Where the disposal area is a new fill site at the water's edge the factors listed for 13. <u>Placing Fill</u>, should be considered.

Proponents are advised that the Ministry of the Environment has special regulations governing on-land disposal of contaminants including a formalized permit system (Sanitary Landfill Permits).

12.5 DREDGE SPOILS DISPOSAL WITHIN CONTAINMENT FACILITIES

The following points may be considered aids in evaluating dyked disposal. The recommendations are not to be construed as factors that would guarantee the structural integrity of dykes or dyked areas. These are not substitutes for sound engineering design and management.

A containment area for spoils disposal should provide: retention of the spoil solids and contaminants within the designated confines so that it will not re-enter any watercourse or cause detriment to adjacent areas and allow only water of acceptable quality to return to the watercourse.

12.5.1 Preliminary Considerations

a) Any area selected as potential containment area should be thoroughly investigated for compatibility with existing and proposed uses.

b) Dyke design should be based on adequate soil, subsurface and stability analyses.

c) Dyke design and construction should be such that the dyke is safe and stable under all construction and operational phases of the disposal area.

d) Containment areas to be built on marshy or other wet land areas should be fully approved by Ontario Ministry of Natural Resources or other appropriate agency.

e) Where necessary prior approval must be guaranteed the proponent with regards to easement access or use of waterlots.

f) In areas where dyke failure could cause irreparable damage, precautionary measures should be formulated well ahead of the actual disposal operation to deal with any emergency.

12.5.2 Capacity Considerations

a) The dykes and dyked area should be constructed such that at any given time it will provide sufficient retention time so that particulate matter may settle out.

In considering the capacity requirements allowances should be made for:
-Possible over dredging (i.e where slightly greater than anticipated volume of material is removed);
-Expansion of dredged material (excavated vs in situ volume);
-Rate of dredging;
-The detention time required for adequate settling;
-Rate of seepage (where allowed) through dykes;
-Runoff of effluent of acceptable quality.

b) Provisions must be made for foundation and embankment settlement to ensure adequate freeboard to prevent overtopping by waves.

12.5.3 Design and Construction Considerations

a) Trees, stumps, etc. in the path of the dykes should normally be cleared and grubbed.

b) Subsurface conditions should indicate the need for overburden or organic material removal.

c) Access roads should be clearly defined and adjacent areas should not be subjected to unnecessary traffic or trampling.

d) The design features of the dyke must be such that it will not impose excessive stresses upon the foundation.

e) The slopes of the dykes must be stable under all construction and operational conditions.

f) Dyke design should incorporate features that would minimize possible failures due to sinking or spreading.

g) i Dykes built on shore close to rivers or streams should be located such that they will not result in later displacement of the river or stream bank.

ii Although not normally condoned, the dyke or containment area built into a watercourse should not restrict natural streamflow to the degree that upstream water levels will be raised or back waters created.

h) Use of heavy construction machinery should be restricted as much as possible to areas directly associated with the project.

i) In instances where equipment other than pipeline dredges are to be used, necessary additional facilities must be constructed, e.g. adequate mooring facilities for direct pumpout from hopper dredges, etc.

12.5.4 Operational Considerations

a) The diameter of the inflow pipeline or the rate of pumping should be such that the rate of discharge would allow adequate retention.

b) The discharge end of the pipeline should be located in such a manner that incoming material would not cause local scour of dyke or build-up material near sluice.

c) The outlet sluice should be located such that there will be no short-circuiting of flow from the inlet.

d) Where feasible the outlet sluices should be located so as to take advantage of any prevailing wind to push turbid waters away from outlet.

12.5.5 Effluent Quality Considerations

a) If possible, adjustable weirs should be used instead of simple outfall pipes to provide adequate detention time and water quality control.

b) Where feasible, a layer of low cover vegetation should be left intact between the outfall and receiving water course to provide additional entrapment of particles in the effluent.

c) In instances where the water within the containment area contain floating debris or surface films, skimming devices should be installed along the sluice.

d) Highly contaminated dredge spoil should be controlled with regards to quality of seepage and ground water contamination.

e) In cases where effluent from an outfall enters a ditch, prior to the watercourse proper, the ditch should be protected as necessary to prevent scouring and turbidity production.

f) Depending on the severity of the problem, especially with colloidal particles, where conventional settling procedures are not adequate, consideration should be given to the use of additional treatment methods such as chemical coagulation, etc. Where necessary to guarantee effluent of acceptable quality, the containment area must be provided with multiple settling basins.

g) Water quality of the effluent shall be such that the MOE "criteria" for the receiving stream are not violated. (See MOE Guidelines and Criteria for Water Quality Management in Ontario.)

12.5.6 Maintenance Consideration

a) The passage of seepage flow through the dyke and foundations must be controlled, so that piping, sloughing and removal of material by solution do not occur.

b) Measures must be taken to stabilize the following conditions:

   Cracks in slopes, bulging and slumping of slopes; excessive pore pressure; wet spots and seepage on outer slope; erosion of slope protection; excessive settlement of dyke foundation.

c) Where simple outfall pipes are used, measures such as the installation of trash screens must be taken to ensure they do not become plugged.

d) The faces of all slopes should be properly protected by vegetative cover, riprap, etc.

e) Provisions must be made to deal with any odour, insect or dust problems that may arise.

DREDGING ADDENDA

INTRODUCTION

Recent findings on the widespread occurrrence of such harmful chemicals as mercury and polychlorinated biphenyls (PCB's) has prompted the Ontario Government to locate and control all sources of these chemicals.

The association between trace contaminants and sediment has been well documented in the literature. Sediment analysis has shown that harbours particularly large industrialized ones accumulate the concentrate, through sedimentation, many contaminants to significantly high levels, but these sedimented contaminants within a harbour are relatively unavailable to the aquatic biota of the open lake.

Dredging itself disturbs sediment but of more importance is spoil disposal by open water dumping where the material disperses over large areas. Even the material that settles at the typical disposal site depths will be subject to agitation and transport via waves and currents over time. The dispersion problem is magnified by the fact that most trace contaminants are associated with the fine fraction of the sediment (e.g. clays) which are very light, take a long time to settle and are easily transported.

Through open water spoils disposal, contaminants become more readily available to the aquatic food chain, eventually contaminating fishes and therefore endangering human health.

Thus sound environmental practice require that contaminanted dredge spoils be confined to safeguard against contamination of the food chain.

POLICY

The Ministry of the Environment will allow open water disposal of dredge spoils that meet or are better than the established guidelines providing existing water uses will not be affected.

Spoil material suitable for open water disposal shall be similar in consistency and equal to or better in quality with respect to contaminant content, to that of the substrate at the disposal site.

GUIDELINES

For MOE evaluations of dredging projects, the following guidelines are suggested as indicative of contaminated sediments subject to the limitations outlined in the next section.

VOLATILE SOLIDS (Loss on ignition at 600°C)	6%
COD	5%
TOTAL KJELDAHL NITROGEN	0.2%
TOTAL PHOSPHORUS (As P)	0.1%
OIL AND GREASE	0.15%
PCB's	0.05 ppm
MERCURY	0.3 ppm
LEAD	50 ppm
ZINC	100 ppm
IRON	10,000 ppm or 1%
CHROMIUM	25 ppm
COPPER	25 ppm
ARSENIC	8.0 ppm
CADMIUM	1.0 ppm
CYANIDE	0.1 ppm
AMMONIA	100 ppm
NICKEL	25 ppm
COBALT	50 ppm
SILVER	0.5 ppm

(Analyses must be on a dry weight basis (i.e. mg/g).

RATIONALE FOR ESTABLISHING GUIDELINES

In the late 1960's regulatory authorities were faced with a need to evaluate the impact of open water dredge spoil disposal. The very large quantities involved (approximately 10 million cu. meters/yr. on the Great Lakes, of which 2 million cu. meters are Canadian), mean that even at trace levels the contaminant loading to the open lake can be substantial.

Staff at the Chicago office of the Federal Water Pollution Control Administration (FWPCA) analysed sediment from the harbours in their jurisdiction and somewhat arbitrarily ranked the parameters as representing light to heavy pollution. The ranking was based on water quality characteristics of the harbour location and to a large degree on the benthos. Where benthos was absent or sharply restricted the sediments were considered heavily polluted. Where pollution tolerant organisms predominated equalled moderate pollution. If the benthos abundance and variability was good the sediments were considered not or only lightly polluted. In August 1968, the Chicago office published the following table.

FWPCA CHICAGO AUGUST 1968

Degree of Pollution of Harbour Sediments (mg/kg dry wt)

Parameter	Light	Moderate	Heavy
Ammonia N	0-25 mg/kg	25-75	over 75
COD	0-40,000	40,000-120,000	over 120,000
Total Iron	0-8,000	8,000-13,000	over 13,000
Lead	0-40	40-60	over 60
Oil & Grease	0-1000	1,000-2,000	over 2000
Phenol	0-0.26	0.26-0.60	over 0.60
Total Phosphorus	0-100	100-300	over 300
Sulphide	0-20	20-60	over 60
% Volatile Solids	0-5%	5-8%	over 8%
Zinc	0-90	90-200	over 200

Following essentially the same procedure the Cleveland FWPCA office published a table in March 1969, to indicate what would be unacceptable for dumping in Lake Erie.

FWPCA CLEVELAND 1969

Sediment Chemical Criteria - Not Acceptable When One or More Exceeds the Following Limits (for dumping in Lake Erie)

Chlorine demand	15	mg/g dry wt
COD	100	"
BOD_5	10	"
Volatile Solids	100	"
Oil & Grease	10	"
Phosphorus	1.5	"
Nitrogen	3.0	"
Iron	50	"

By 1971 these tables had been combined as the Jensen criteria and adopted by the new Environmental Protection Agency (EPA) for use across the nation in either fresh or marine waters, to determine the suitability of open water spoils disposal as shown below:

EPA 1971

When concentrations, in sediments, of one or more of the following pollution parameters exceed the limits expressed below, the sediment will be considered polluted in all cases and, therefore, unacceptable for open water disposal.

Sediments in Fresh and Marine Waters	Concentration in % (dry wt. basis)
*Volatile Solids	6.0
Chemical Oxygen Demand (C.O.D.)	5.0
Total Kjeldahl Nitrogen	0.10
Oil-Grease	0.15
Mercury	0.0001
Lead	0.005
Zinc	0.005

*When analyzing sediments dredged from marine waters, the following correlation between volatile solids and C.O.D. should be made:

$$T.V.S\ \%\ (dry) = 1.32 + 0.98\ (C.O.D.\%)$$

If the results show a significant deviation from this equation, additional samples should be analyzed to insure reliable measurements.

In the early 1970's the Ontario Water Resources Commission (OWRC) drafted guidelines for The Review of Proposed Dredging & Spoils Disposal Operations. The parameter levels selected by the OWRC to evaluate dredging projects were modified from the American criteria to reflect our own experience with sediment data from Canadian harbours on the Great Lakes. In the case of mercury, the guideline was based not on a correlation with impaired water quality or benthos but an apparent correlation with mercury in fish levels higher than the 0.5 ppm guideline for human consumption. The Ontario practice differed significantly from the stated American practice in that disposal operations were not rejected out of hand merely because one parameter in one sample exceeded the guidelines. In Ontario each project is considered on a case by case basis and some flexibility is allowed according to local conditions and the nature of the project under evaluation. The factors to be considered in an evaluation were formalized with the publication in January 1976, of the MOE document Evaluating Construction Activities Impacting on Water Resources. MOE has been using the following parameter levels as guidelines to suggest that contamination has occurred.

Parameter	% Dry Wt.
Percent loss on ignition at 600°C (Organic Content)	6.0
Chemical Oxygen Demand (COD)	5.0
Total Kjeldahl Nitrogen (as N)	0.2
Total Phosphorus (as P)	0.1
Oil and Grease (ether or chloroform solubles)	0.15
Total Mercury	0.00003

Several limitations exist to prevent application of these guidelines as absolute criteria.

1) The guidelines are based on a bulk sediment analysis. Changes in substrate type may dramatically change the concentration of contaminants without necessarily indicating any additional contaminant input, simply because contaminants are associated primarily with the fines (clay size fraction).

2) The individual parameter levels are empirically derived and relate more to some incremental change above background levels for the nearshore zone of the Great Lakes, than to a level related to known adverse effects on biota. Most of the parameters have been selected on the basis of harbour studies, where they appear together with a large number of other chemicals in known and unknown quantities, so that the synergistic effects between parameters are not adequately understood.

3) Individual parameter levels may be exceeded under natural conditions e.g. organic content in marsh sediments, metals in some areas of mineralization. Sufficient sampling should be undertaken to establish local background conditions.

4) The importance of sediment chemistry in bioaccumulation of trace contaminants is poorly understood. Direct uptake of PCB's and mercury has been demonstrated from sediments to fish under lab conditions but the factors influencing the rates of uptake have not yet been quantified.

The International Joint Commission (IJC) has recommended the establishment of compatible criteria between Canada and U.S. to designate contaminated sediments. While this may provide the necessary stimulus for research to overcome the limitations mentioned above, it would be unrealistic to assume that fixed numerical criteria will have universal applicability in this complex field.

Region V of the U. S. EPA has reverted to a set of figures to express ranges of pollution as shown below.

EPA 1977 GUIDELINES
FROM IJC UPPER LAKES REPORT APPENDIX C

Figure I. Ranges used to classify sediments from Great Lakes Harbours. All ranges in mg/kg dry wt. unless other wise noted.

	NONPOLLUTED	MODERATELY POLLUTED	HEAVILY POLLUTED
Volatile Solids	<5%	5% - 8%	>8%
COD	<40,000	40,000-80,000	>80,000
TKN	<1000	1000-2000	>2000
Oil & Grease (Hexane Solubles)	<1000	1000-2000	>2000
Lead	<40	40-60	>60
Zinc	<90	90-200	>200
Mercury	<1.0	N.A.	>1.0

Figure II. Supplementary ranges (poorer Data Base) used to classify sediment from Great Lakes harbors. All ranges in mg/kg dry weight unless otherwise noted.

	NONPOLLUTED	MODERATELY POLLUTED	HEAVILY POLLUTED
Ammonia	<75	75-200	>200
Cyanide	<0.10	0.10-0.25	>0.25
Phosphorus	<420	420-650	>650
Iron	<17,000	17,000-25,000	>25,000
Nickel	<20	20-50	>50
Manganese	<300	300-500	>500
Arsenic	<3	3-8	>8
Cadmium	*	*	>6
Chromium	<25	25-75	>75
Barium	<20	20-60	>60
Copper	<25	26-50	>50

*Lower limits not established

PROCEDURES

Proposals for dredging and open water disposal will be evaluated on a site specific basis. Major emphasis will be placed on the possible effects of the proposal on water quality and water use in the area.

CLEAN SPOILS

Spoils resulting from capital works (i.e. areas not previously dredged) will in many instances be suitable for open water disposal as far as contaminant levels are concerned. The material from such projects commonly includes clean littoral drift sands, boulders, blasted rock and clay till. If no water quality or water use impairment will result the material may be placed in open water at a site where the spoils generally match the substrate. In some cases it may be possible to locate disposal sites for clean, coarse material that would enhance fish habitat. Littoral drift sands should be placed on the downdrift beach wherever possible to minimize erosion.

CONTAMINATED SPOILS

Spoils that exceed the MOE sediment quality guidelines in any parameter may be unsuitable for open water disposal, based on water quality or water use or public health reasons. Such material which usually results from maintenance dredging (e.g. harbours etc.) must be confined within dyked areas or disposed of upland so as to prevent entry to a water-course. The degree of confinement may be varied to suit the contaminant. For example no escape of toxic PCB's should occur but it may be sufficient to filter out wood fiber through porous berms.

13. PLACING FILL OR MARINE STRUCTURES

This section includes landfills, causeways, cofferdams, dams, wharves, breakwaters, shore protection, bridge piers, etc.

a) No material shall be placed where it will be eroded and cause a turbidity level which exceeds the MOE published "criteria" for the particular water uses (Guidelines and Criteria for Water Quality Management in Ontario).
b) Runoff from fill areas shall be controlled so that water quality is not degraded in the adjacent waterbody.
c) Material which does not meet the guidelines for spoils disposal in open water is generally unsuitable for unconfined dumping in a watercourse.
d) Where toxic or hazardous materials or excessive quantities of nutrients are included in the fill, measures must be taken to ensure that these substances do not gain access to surface water or ground water.
e) No filled areas or other structures should be located such that they restrict the flow, or alter the existing current pattern in a manner that contributes to water quality impairment.

13.1 LANDFILL

Landfill in this case refers to the filling in of a portion of a body of water and has no relation to an on-land sanitary landfill. In most cases a landfill is a stone or rubble armoured earthfill structure; (but also include areas enclosed by sheet pilings and other such structures which will be discussed later).

13.1.1 Possible Effects

a) May cause increased turbidity during and after construction.

b) May distrupt or restrict the circulation pattern of water in the vicinity of intakes and outfalls.

c) The structure may result in the formation of embayments pocketing a certain amount of water which is restricted in exchange with the main body of water. The embayment may trap floating debris such as wood, dead fish, etc. If the accumulated material is not removed periodically, nusiance conditions may arise.

d) Filling in a portion of a body of water totally removes the area from use by aquatic organisms. Benthic habitats and fish spawning areas would be lost.

e) Inadequate planning and poor construction may result in loss of armour material and fill to wave action. The washed out fill material may end up along recreational

beach areas creating muddy bottoms and loss of recreational facilities of the area. In addition the turbidity would create aesthetic problems. Washed out fill could also cause detriment by smothering benthos, covering spawning areas and in addition create problems for water treatment plants in the area.

f) The structure may disrupt littoral transport of material along the shore. This could lead to beach accretion on the updrift side of the structure with considerable erosion on the downdrift side.

g) More often than not the core material for landfill is obtained from construction areas and dredge spoils. These sources may contain considerable amounts of industrial pollutants which could be introduced in the aquatic environment. Potential fill material should be inspected and where warranted rejected.

13.1.2 Evaluation

The design plans and written description of the landfill project should include information on the following:

- wave energy
- lake levels (high and low)
- storm set-up (temporary rise in lake stage induced by storms)
- offshore depth contours
- littoral transport patterns and net transport
- direction and intensity of winds
- depth to bedrock
- type of bed material (foundation conditions)
- anticipated depth of scour
- type of beach material and beach characteristics (receding, steep bluffs, etc.) type of armour to be used, type and source of fill, construction procedures and sequence, water uses in the area (location of outfalls, intakes, etc.). Additional information outlined in Appendix A must be provided.

13.1.3 Recommendations

a) Design wave height should take into account the high water levels and storm set up values.

b) The sides exposed to direct wave action should be properly armoured to prevent damage by wave action.

c) Armour stone size and quantity should be such that the structure would safely withstand the most severe expected wave energy.

d) A filter-blanket of small stones or a woven filter cloth should be used beneath the armour layer to prevent the loss of fines such as sand from beneath.

e) Adequate toe protection (positive slope) must be provided to a depth below the anticipated scour limit to prevent toe failure.

f) Segregation of armour material should be such as to eliminate voids in armour wall.

g) The structure should be examined periodically after construction for defects or damage due to settling. Armour material should be added where required until stability is established.

h) Where it is intended that wave action would achieve a stable configuration, enough material must be placed to compensate for the readjusted slope. Material should be sized to adjust its slope without significant losses to the water column.

i) The top of the armour should be extended sufficiently landward to protect the fill against run-up water from splashes.

j) Adequate armouring may necessitate a layer of smaller stone followed by larger material on the outer face.

k) Work being conducted in the vicinity of river mouths or other areas used as migratory routes by spawning runs should be planned so as not to interfere with such runs. Operations in recreational areas should be timed so as not to unduly interfere with recreational uses.

l) Construction procedures and sequence should be planned such that loose fill will not be dumped during severe weather conditions.

13.1.4 Comments

Most landfill failures have been known to occur as a result of inadequate toe protection and armouring during severe storms.

14. SHORELINE DEVELOPMENT

This section is divided into two parts:

a) Development on the lakeward side of the shore. More appropriately termed shoreline protection and,

b) Development on the landward side of the shore such as urban development, etc. discussed in Section 3.

14.1 SHORELINE PROTECTION

This term refers to structures such as groynes, breakwaters, etc. used to protect a given stretch of shoreline. The functions of such structures are:

a) To protect the shoreline and beach from direct wave action.
b) To prevent loss by erosion or depletion of beach material.

c) To protect from ice damage.

d) To capture littoral drift material for beach building.

Under natural conditions along a given stretch of shoreline an equilibrium is set up where material is removed and deposited through littoral transport. In the areas where the amount of material deposited and that removed balances out, a stable beach results. If the amount of material deposited is greater than that removed, beach accretion occurs. If the amount of material removed is greater than that deposited, beach erosion occurs. The three major sources of beach material under natural conditions are:

a) Material moved through littoral transport from adjacent beaches.

b) Sediment material brought down by streams.

c) Material resulting from erosion of coastal formations other than beaches such as cliffs and dunes, etc.

Except around the mouths of rivers bearing heavy sediment loads, the most significant source of beach material is through littoral transport of material eroded from updrift beaches. The direction of material carried through littoral transport may vary periodically but over a long term period a net movement predominates and the material deposited is termed net littoral drift.

The work of transporting littoral material is done through wave energy. The wave velocity most effective in transport and erosion is that occurring at the bottom and varies with

water depth, wave height and wave period. As waves move into shallow water the bottom velocity, as a result of decreasing depth, increases until the waves break, dissipating most of their energy. This breaking area is where most erosion and transport occurs. As the waves rush up onshore the remaining energy is dissipated. Thus with regards to erosion and transport of material the wave "breaking" point to the rush up zone is the most significant.

In studying a given stretch of shoreline for proposed modification, a physiographic unit must be considered. A physiographic unit may be defined as a segment of shoreline along which natural, physical forces act such that the area is not influenced by activities from adjacent areas. It would represent for example the proximal limits of adjacent eroding and accreting beaches.

14.2 STRUCTURAL MODIFICATIONS

14.2.1 Groynes

Groynes are structures running lakeward from and perpendicular to shore. They are usually constructed of stone, stone filled gabion baskets, and steel or timber piles and may be permeable (allowing some littoral drift to pass) or impermeable completly blocking littoral transport. Groynes may be used to retard erosion of an existing beach, capture littoral material to build a beach or protect the shore from wave attack. Groynes may be used singly or in combination (groyne field).

14.2.2 Jetties

Jetties are usually built at the mouth of rivers and extend from shore lakewards, parallel to the channel axis and are designed mainly to prevent infilling of the channel in the littoral zone of the lake. They however block the passage of littoral drift creating accretion on the updrift side. When this side is filled excess material will bypass the structure and shoal the channel. At the same time downdrift areas may be eroded.

14.2.3 Breakwaters

These are usually offshore structures used to protect a given area from wave action. Thus they may be used to provide shelter for crafts. By destroying wave action, the principal material transport force is eliminated causing starvation of downdrift beaches with excessive accretion on the updrift side. After the updrift side has been filled in material will tend to bypass the structure causing infilling of the harbour.

14.2.4 Evaluation

Littoral transport to an area may be thought of as rate of supply or loss of material with periods ranging from storm durations to years. Each physiographic unit of a shore-line is a unique one and must be evaluated as such. Analogies must not be substituted for proper detailed studies. A sound plan for beach protection should include information on the following:

- Direction and characteristics of wind, waves, shore currents.
- Normal, high, low and storm lake levels.
- Size, gradation and location of beach and feeding headland materials.
- Amount, direction and rate of littoral transport.
- Actual and stable beach slope.
- Winter and summer variations of beach profiles.
- Offshore, foreshore, beach and backshore topography.
- Structural foundation conditions.
- Water, ice and earth forces expected on the proposed structures.
- Construction and maintenance of protected upland areas.
- Soil profile to the depth of projected structural penetration.
- Existing and proposed uses of eroding and accreting zones.

14.2.5 Recommendations

a) The height, length and permeability of the groyne should be such as not to completely block littoral transport and consequently erode downdrift beaches.

b) If a groyne field is used, the distance between adjacent groynes should be such that they would not severely deflect littoral drift offshore.

c) The predominant direction of littoral transport may be observed from (a) existing structures such as groynes, jetties, etc. with accretion on the updrift side. Studies should be conducted for at least one year to avoid misinterpretation due to seasonal variation in direction; (b) observations at headlands - cliffs cut by waves and the absence of beach would indicate the downdrift side of wide stable beaches (updrift). The receding cliffs may be considered the updrift extremity of a different physiographic unit; (c) hydrologic charts or current measurements.

d) Littoral transport should be measured in terms of amount-drift per unit time (year).

e) The size and amounts of material used for construction should be such that the structure would withstand wave energy without danger of structural failure.

f) Construction should not result in turbidity levels exceeding MOE's published permissible criteria.

g) The structure should not be located such that it would restrict flow or alter existing current pattern in a manner that contributes to water quality impairment.

h) Work should not interfere with recreational activities or fish spawning areas and migratory runs.

14.2.6 Comments

Studies have shown that modifications to littoral pattern as a result of groynes, etc. do not balance out. In most cases the length of eroding shore is greater than the length of the beach of the built-up shore.

15. WATERCOURSE CROSSINGS FOR PIPELINES, WATERMAINS, SEWERS, ETC.

Applications for watercourse crossings should include data pertinent to the items listed below:

a) Certain crossings have physical characteristics such as high current velocities and poor mixing qualities which make them especially "sensitive" in regard to the effects on downstream water quality. Additionally, some water bodies by virtue of the uses to which they are put, are "sensitive" to even short-lived degradation of water quality. For such crossings, detailed proposals on how water quality impairment will be minimized should be provided.

b) Dredging operations should not be conducted on prime recreational lakes or rivers during peak use periods.

c) Granular material must be used for underwater backfill in areas deemed "sensitive" by the Ministry of the Environment.

d) Herringbone trenching should be used, where possible, along the route of excavation to direct surface runoff away from newly consolidated areas with a minimum of erosion.

e) The removal of vegetation from the sloped approaches to the watercourse should be kept to the minimum necessary for construction.

f) Cutting on the pipe trench at the bank of the watercourse should not be undertaken until the actual pipe laying is to take place to minimize silt input to the watercourse.

g) The work site should be graded to ensure that the trench adjacent to the crossing is not flooded with surface runoff since that would result in a discharge of turbid water to the watercourse.

h) The sloped approaches to the watercourse that have been exposed by the construction must be stabilized immediately after construction to prevent erosion of the banks.

i) Unless the excavated material from the bed of the watercourse is suitable for backfilling the trench, it should be removed and deposited on land where it will not regain access to any watercourse.

j) Aquatic weeds uprooted or cut prior to or during trenching operations must be contained and adequately disposed of on land.

k) No discharge shall be made from pipeline cleaning or pressure testing operations in a manner that could impair water quality or cause erosion.

16. UNDERWATER BLASTING AND EXCAVATION

Such activity is related to seismic exploration, deepening of ports, ship channel improvements, construction of intakes and outfalls for thermal generating stations, municipal and industrial water and wastewater, etc.

Blasting is used to fragment rock to sizes that can be adequately picked up by dredges, to remove obstructions and occasionally for trenching.

16.1 THE EFFECTS OF UNDERWATER BLASTING

Damage may result from:

a) Vibration - energy being transmitted from one particle to another as elastic waves. This may affect structures such as piers, groynes, etc. depending on the charge used and the location of the structure.

b) Changes in water pressure - This may have detrimental effects on fishes such as rupturing of swim bladders (the most significant effect). Damage may also result to the muscle tissue, abdominal cavity, blood vessels and internal organs.

   Previous studies have revealed the following:

   i Peak pressure associated with damage to fish vary among species.
   ii Immediate lethality is observable within half an hour following the blast.
   iii Significant fish kills may occur at a later time from sustained damage.

   It appears the most sensitive organ that could be affected is the swim bladder (used to control hydrostatic pressure). Moreover, fishes with closed swim bladders are more susceptible to the blasting. The effects on bottom feeders (usually without swim bladders) seem to be significantly less than for species inhabiting the upper waters.

   It appears that fish are not driven away from areas as a result of blasting.

c) Flying Rock - This is not significant unless the depth of the water is less than half a foot.

17. SMALL DAMS

Refer to structures built across rivers to "hold back" water for agricultural, industrial, power generating use, etc.

Dams may be built of rock, earth or concrete material and vary in height depending on the volume of the proposed reservoir. The impacts produced during dam construction are almost similar to those from road and bridge construction, the primary problem being sedimentation (see also Section 7.3).

17.1 CONSTRUCTION EFFECTS

a) Construction often results in excessive stream fording by heavy equipment. This results in damage to bed contour and generation of sediment and turbidity.

b) Turbidity may cause detriment to water supply systems, recreation, and spawning grounds.

c) Could restrict streamflow especially during low flow periods.

d) Interim and final structures (bridge, culverts, etc.) could impede fish migration.

e) May result in spills of hazardous construction chemicals or oils into the watercourse.

f) Gravel taking from streambed could result in formation of stagnant water pools resulting in nuisance conditions.

g) Inadequate planning and poor construction techniques could result in mud slides or complete washout during heavy rainfalls.

h) Gravel washing (gravel is usually washed to remove fines prior to use in construction) may increase turbidity levels in the watercourse and sedimentation of streambed.

17.2 EVALUATION OF SMALL DAM PROPOSALS

Information should include data on (a) type and source of material to be used; (b) water uses in the area; (c) fish migration patterns and spawning areas; (d) type of bed material (foundation conditions); (e) depth to bedrock; (f) method of construction (including reservoir stripping); (g) method and location of spoils disposal; (h) streamflow data (maximum, minimum, average); (i) expected flows during construction; (j) areas where stream will be crossed by machinery and provisions for such activities.

17.3 RECOMMENDATIONS

a) The structure should be constructed so as not to eliminate fish migration. This may require use of fish ladders, etc.

b) Final design height should be such that the structure would allow enough water to pass in order to maintain adequate downstream flows.

c) The integrity of the structure should be such that it will safely withstand maximum expected flows and geologic changes such as weathering, earth tremors, etc.

d) Work should be done during low flow periods (reservoir stripping during dry weather).

e) The material and method of construction should be selected such that installation and removal of interim structures will result in minimum water quality degradation.

f) Interim culverts or bridges should convey base flow and pass maximum expected flow without themselves being washed out or cause upstream ponding.

g) Access roads to the work site should be clearly defined and adjacent areas should not be subjected to unnecessary traffic. Temporary roads should be scarified, seeded and mulched upon completion of the project.

h) Temporary stream diversion or flow restriction for construction (a) <u>blocking upstream flow</u> - this should be done using clean boulders and gravel to significantly reduce velocities. The upstream face of the barrier may then be sealed with earthfill; (b) <u>restriction of flow</u> - regulation of releases from existing dams should be used advantageously, e.g. if there is a dam upstream of the construction area and water releases from the dam can be controlled then such controls should be used to allow only the minimum amount water possible to be released without endangering the existing dam or areas upstream of its (see Diagram 17-A) (c) <u>cofferdams</u> may be used to build sections of the dam while maintaining flow in the other half of the stream. Cofferdams should be as watertight as possible and should not result in any significant degree of pollution (see Diagram 17-B); (d) <u>channel diversion</u> - the temporary channel should be excavated while maintaining upstream and downstream plugs. The downstream plug should be first removed allowing enough water to back up into the new channel prior to removal of the upstream plug (see Diagram 17-C).

i) Gravel (to be used as fill for the dam) taking from the streambed should not be done until the stream has been diverted (flow blocked) and bed dewatered.

j) Gravel wash water should be ponded and reused. Discharges from such ponds may require chemical treatment or settling basins prior to discharge in order to meet MOE's published criteria (see also Guidelines on Desilting Basins).

k) Upon completion of the project, all temporary structures, construction debris and spoils must be removed from the streambed and disposed of in such a manner that they would not re-enter the watercourse.

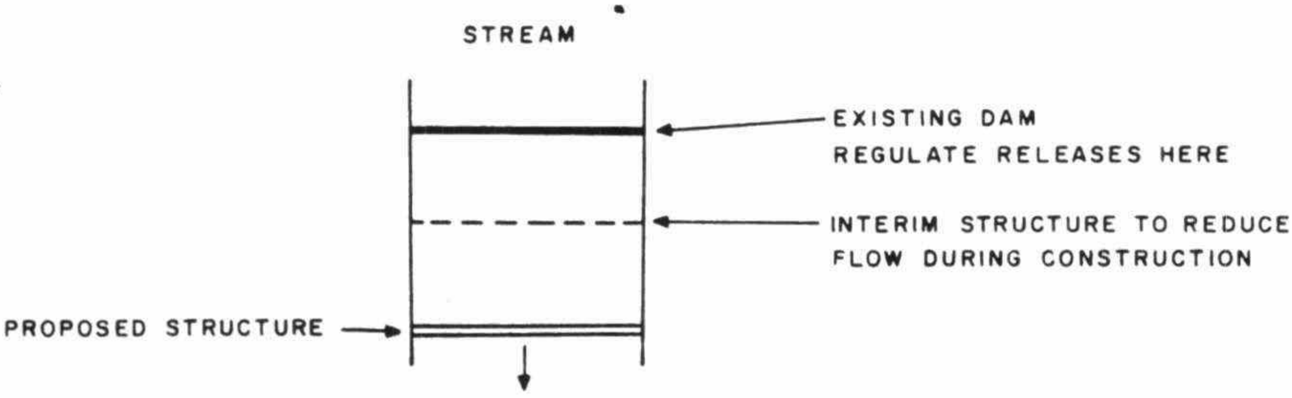


DIAGRAM 17-A

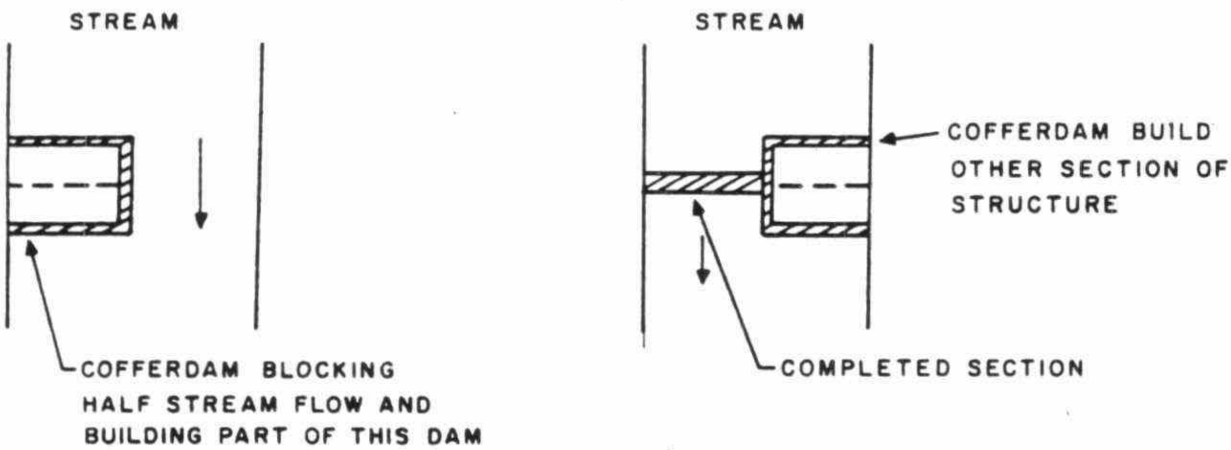


DIAGRAM 17-B

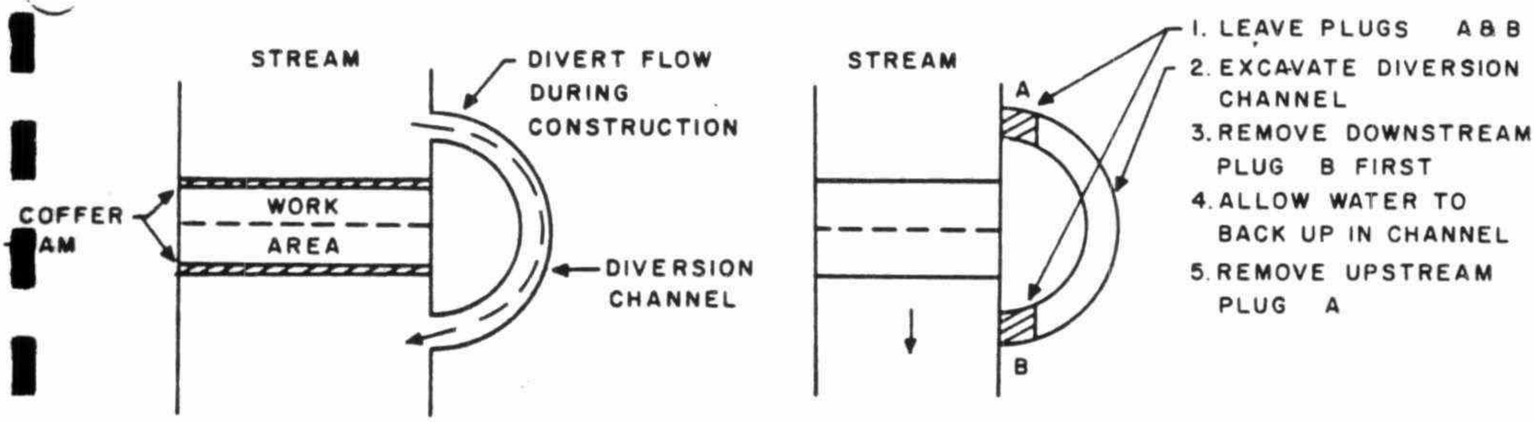


DIAGRAM 17-C

18. OFFSHORE EXPLORATORY DRILLING

Refers to exploratory drilling for oil and natural gas in offshore waters. The steps include locating of potential area through geophysical surveys, bottom sampling and bedrock sampling (core drilling). When an area has been selected as a potential site, the exploratory well is drilled.

18.1 DRILLING PLATFORMS

a) Platforms on piles
b) Jackup structures (barges)
c) Floating vessels
d) Drilling through ice

An important medium in the drilling process is the drilling fluid (mud) used to -

a) Keep the well under control (hydrostatic pressure)
b) Lubricate the drill bit
c) Provide a wall on drilled holes
d) Carry drill cuttings to the surface

Drilling fluids may be water-base or oil-base and consist mainly of -

a) Suspended solids (major component)
b) Metal chlorides
c) Strong alkalies
d) Chromium compounds
e) Bactericidal agents

18.2 RECOMMENDATIONS

a) Proposals to conduct exploratory drilling should include provisions for adequate protective devices such as blow-out preventers, etc. to safeguard against mishaps.
b) The drilling platform should safely withstand wavé energies and ice pressures.
c) Drip pans or other collecting devices must be installed under the drilling rig to collect fluid spills (mud, oil, etc.). The pans must be drained at frequent intervals and the contents disposed of on shore in an approved manner.
d) Sewage and trash must be collected, transported to shore and disposed of in approved landfills.
e) The material and methods used to drill in areas with salt formations should be chosen so as to prevent salt solution from contaminating surface waters. and shallower aquifers.
f) Re-entry holes and abandoned holes should be plugged so that fluids from one level would not escape to another level or to surface waters.

g) All drill cuttings must be treated to remove oil.
h) All oil-base muds must be taken to shore and adequately disposed of in an adequate manner.
i) Work should not be conducted in areas where the operation could affect water intake systems, recreational areas or spawning areas.

INFORMATION REQUIRED FOR ENVIRONMENTAL ASSESSMENT WATER RESOURCES ASPECTS — TYPE OF ACTIVITY

INFORMATION REQUIRED *	STREAM & CHANNEL MODIFICATION	URBAN DEVELOPMENT	REMEDIAL DREDGING	MINING	DREDGING	OPEN-WATER DISPOSAL	LAND DISPOSAL	LANDFILL INTO WATERCOURSE	SHORE PROTECTION	UTILITIES	DAMS & RESERVOIRS				
INFORMATION ON THE PROJECT SITE LOCATION	x	x	x	x	x	x	x	x	x	x	x				
QUANTITY OF MATERIAL					x	x	x	x							
TYPE OF EQUIPMENT	o		o	o	o	o	o	o		o					
PROCEDURES OF OPERATION	x	x	x	x	x	x	x	x	x	x	x				
SEQUENCES OF OPERATION	x	x	x	o	x	x	x	x	x	x	x				
TIME OF OPERATION	x	x	x	x	x	x	x	x	x	x	x				
DURATION OF OPERATION	x	x	x	x	x	x	x	x	x	x	x				
FREQUENCY OF MAINTENANCE	x	x	x	x	x	x	x	x	x	x	x				
EXTENT OF CUTS & FILLS					o						o				
BLASTING RATIO															
WATERSHED CHARACTERISTICS ANNUAL PRECIPITATION	o	x		x			o				x				
SEASONAL VARIATION IN PRECIPITATION		x		x							x				
RAINFALL INTENSITY & DURATION		x		x							x				
SOIL TYPE (HYDROLOGIC CHARAC.)	o	x													
SOIL ERODIBILITY	x	x		x				x	x		x				
SLOPE	x	x		x				x	x		x				
TYPE & DENSITY OF VEGETATION		x		x							x				
EVIDENCE OF SLIDES OR SOIL MOVEMENT	x	x		x							x				
LOCATION OF STREAM & TRIBUTARIES	x	x	o	x	o	o	x	x	x	o	x				

* X : REQUIRED O : DESIRABLE

INFORMATION REQUIRED FOR ENVIRONMENTAL ASSESSMENT WATER RESOURCES ASPECTS — TYPE OF ACTIVITY

INFORMATION REQUIRED *	STREAM & CHANNEL MODIFICATION	URBAN DEVELOPMENT	REMEDIAL DREDGING	MINING	DREDGING	OPEN-WATER DISPOSAL	LAND DISPOSAL	LANDFILL INTO WATERCOURSE	SHORE PROTECTION	UTILITIES	DAMS & RESERVOIRS				
WATER USES RECREATIONAL	X	X	X	X	X	X	X	X	X	X	X				
TOTAL BODY CONTACT	X	X	X	X	X	X	X	X	X	X	X				
PARTIAL BODY CONTACT	X	X	X	X	X	X	X	X	X	X	X				
FISHING	X	X	X	X	X	X	X	X	X	X	X				
FISHERIES PREDOMINANT TYPES		X													
SPECIES MOST SENSITIVE TO CHANGES		X			X	X		X			X				
SPAWNING AREAS		X	X		X	X				X	X				
MIGRATORY RUNS – SPAWNING SEASONS		X	X		X	X				X	X				
DOMESTIC – INDUSTRIAL USES LOCATION OF INTAKES AND AMOUNT WITHDRAWN	X	X	X	X	X	X	X	X	X	X	X				
LOCATION OF OUTFALLS AND TYPES OF WASTES	X	X	X	X	X	X		X	X	X	X				
SPECIAL USES															
SEDIMENT QUALITY % LOSS ON IGNITION AT 600 c (ORGANIC CONTENT)					X	X	X								
COD					X	X	X								
TOTAL KJELDAHL (AS N)					X	X	X								
TOTAL PHOSPHORUS (P)					X	X	X								
OIL & GREASE					X	X	X								
TOTAL MERCURY					X	X	X								
TOTAL LEAD					O	O	O								
TOTAL ZINC					O	O	O								

Appendix A – 3

INFORMATION REQUIRED FOR ENVIRONMENTAL ASSESSMENT WATER RESOURCES ASPECTS – TYPE OF ACTIVITY

INFORMATION REQUIRED *	STREAM & CHANNEL MODIFICATION	URBAN DEVELOPMENT	REMEDIAL DREDGING	MINING	DREDGING	OPEN-WATER DISPOSAL	LAND DISPOSAL	LANDFILL INTO WATERCOURSE	SHORE PROTECTION	UTILITIES	DAMS & RESERVOIRS
SEDIMENT QUALITY (CONT'D)											
GRAIN SIZE					o	x	x				
SPECIAL STUDIES											
DETAILED BIOASSAY / BIOLOGICAL					o	o					
DISPERSION STUDIES							x				
LAKE STUDIES											
WIND DIRECTION & INTENSITY						x		x	x		
CURRENT PATTERNS					x	x		x	x		
WAVE ENERGY								x	x		
DEPTH PROFILES					x	x		x	x		
LAKE LEVELS					x	x		x	x		
NET LITTORAL DRIFT								x	x		
SEASONAL VARIATION IN LITTORAL DRIFT								x	x		
LOCATION OF MARINE STRUCTURES					x	x		x	x		
WATER INTAKES & OUTFALLS					x	x		x	x		
THERMAL & INDUSTRIAL DISCHARGES					x	x		x	x		
STORM SET-UP VALUES AND EXPECTED OCCURENCES								x	x		

* X: REQUIRED O: DESIRABLE

INFORMATION REQUIRED FOR ENVIRONMENTAL ASSESSMENT WATER RESOURCES ASPECTS – TYPE OF ACTIVITY

INFORMATION REQUIRED *	STREAM & CHANNEL MODIFICATION	URBAN DEVELOPMENT	REMEDIAL DREDGING	MINING	DREDGING	OPEN-WATER DISPOSAL	LAND DISPOSAL	LANDFILL INTO WATERCOURSE	SHORE PROTECTION	UTILITIES	DAMS & RESERVOIRS				
BEACH & SHORELINE TYPE OF BEACH MATERIAL		X						X	X						
SEASONAL VARIATION IN MATERIAL								X	X						
OFFSHORE & NEARSHORE PROFILES								X	X						
RECREATIONAL AREAS LOCATION								X	X						
STREAM CHARACTERISTICS FLOWS (MAX., MIN., AVG.)	X	X								O	X				
FLOODING BEHAVIOR	X	X									X				
STREAM BED MATERIAL	X	X								X	X				
WIDTH, DEPTH, GRADIENT	X	X								X	X				
POOL – RIFFLE RATIO	X	X									X				
WATER QUALITY STUDIES TEMPERATURE		X									X				
DISSOLVED OXYGEN		X									X				
TURBIDITY											X				
B O D											X				
MANGANESE															
C O D															
TOTAL SOLIDS											X				
SUSPENDED SOLIDS		X													
ACIDITY															
ALKALINITY															
HARDNESS															
pH		X									X				

X X REQUIRED

INFORMATION REQUIRED FOR ENVIRONMENTAL ASSESSMENT WATER RESOURCES ASPECTS – TYPE OF ACTIVITY

INFORMATION REQUIRED *	STREAM & CHANNEL MODIFICATION	URBAN DEVELOPMENT	REMEDIAL DREDGING	MINING	DREDGING	OPEN-WATER DISPOSAL	LAND DISPOSAL	LANDFILL INTO WATERCOURSE	SHORE PROTECTION	UTILITIES	DAMS & RESERVOIRS				
WATER QUALITY STUDIES (Cont,d)															
TOTAL KJELDAHL															
NO_2 –N				x											
NO_3 –N															
SULPHATE															
CHLORIDE		x													
CONDUCTIVITY				x											
BACTERIOLOGY – T.C. F.C. F.S.		x		x							x				
IRON															

* X : REQUIRED O : DESIRABLE

APPENDIX B

THE USE OF ANALYTICAL DATA

Water quality data should provide information on the following:

1. Maximum, minimum and average values of parameters measured.
2. Temporal variation in parameters measured.
3. Baseline data and deviations from baseline.
4. Requirements for most sensitive water use in the respective watercourse.
5. Variation in parameter values according to river reach or distance from shore (spatial distribution).

Evaluation

Studies should be geared towards determining the following:

1. Sources contributing adversely to the values of the parameters measured.
2. Areas of the watercourse already heavily stressed and areas that require protection.
3. Extraneous factors (outside watercourse proper) that could significantly change the parameter value once conditions have been altered.

APPENDIX C: Information Acquisition

Type	Source	Comments
Water Quality Data	Ontario Ministry of the Environment Water Quality Data Reports Water Resources Branch	For most significant streams and near shore Great Lakes
Stream flow and Sediment Data	Environment Canada District Engineer Water Survey of Canada Water Resources Branch Dept. of the Environment P.O. Box 335 GUELPH, Ontario, N1H 6K5	Continuous streamflow records for most major streams; Sediment quantity data for selected streams
Existing Wells	Ontario Ministry of the Environment Regional Offices	Depths, capacities, age, drillers, etc.
Fish Spawning Runs and Other Fisheries Information	Ontario Ministry of Natural Resources Regional Offices	
Municipalities Townships	Municipal Directory or Min. of Treasury, Economics and Intergovernmental Affairs Frost Building South Queen's Park, Toronto M7A 1Y7 or Ontario Gov't Bookstore 880 Bay St., Toronto	Populations; Engineer or Supt.
Guidelines and Criteria for Water Quality Management in Ontario	Min. of Environment (Ont.) Booklet	Water quality requirements for normal uses of Ont. watercourses
Conservation Authorities	Conservation Authority Officer or Min. of Natural Resources Conservation Authorities Br. 5th Floor, Whitney Block Queen's Park, Toronto M7A 1W3	Information on land and water uses; Streamflow; Reservoir operations
Hydrographic Charts	Environment Canada Notice to Mariners Unit Canadian Hydrographic Service Marine Sciences Directorate Ottawa, Ontario K1A 0E6	River or lake contours; Bottom types; Navigation aids

APPENDIX C (continued)

Type	Source	Comments
Climate Precipitation	Environment Canada Atmospheric Services Br. 4905 Dufferin Street DOWNSVIEW, Ontario	Historical, information on precipitation, wind, etc.
Soil Data	Ont. Dept. of Agriculture Food-Land Development Br. 1200 Bay Street 2nd Floor, Toronto	
Land Use	Min. of Treasurey, Economics & Intergovernmental Affairs Regional Planning Br. Frost Building North Toronto, Ontario	
Shoreline Erosion	MNR and Environment Canada	Coastal Zone Atlas
Existing Mines	MNR-Industrial Minerals Section	
Dams	MNR-Conservation Authorities	
Geology and Ground Water (Quality and Quantity)	Min. of Environment (Ont.) Hydrology and Monitoring 1 St. Clair Avenue West 3rd Floor, Toronto	Map and List of all study reports for Ontario